

EXHIBIT A

United States Patent [19]

McCartney, Jr. et al.

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[45] Date of Patent: Jan. 18, 1994

[54] DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY

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[73] Assignee: Honeywell Inc., Minneapolis, Minn.

[21] Appl. No.: 911,547

[22] Filed: Jul. 9, 1992

[51] Int. Cl.⁵ G02F 1/133

[52] U.S. Cl. 359/40; 359/69

[58] Field of Search 359/69, 40, 41

[56] References Cited

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5,128,783	7/1992	Abileah et al.	359/40
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IBM Corp., "Polarized backlight for liquid crystal display", IBM Technical Disclosure Bulletin, vol. 33, No. 1B, Jun. 1990, pp. 143-144.

Primary Examiner—William L. Sikes

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Attorney, Agent, or Firm—Dale E. Jepsen; A. Medved

[57]

ABSTRACT

A display apparatus including a light source, a liquid crystal panel, and one or more directional diffuser lens arrays disposed therebetween provides a tailored variation of luminance with viewing angle, a uniform variation of luminance with viewing angle within a first predetermined range of viewing angles and a concentration of light energy within a second predetermined range of viewing angles.

3 Claims, 11 Drawing Sheets

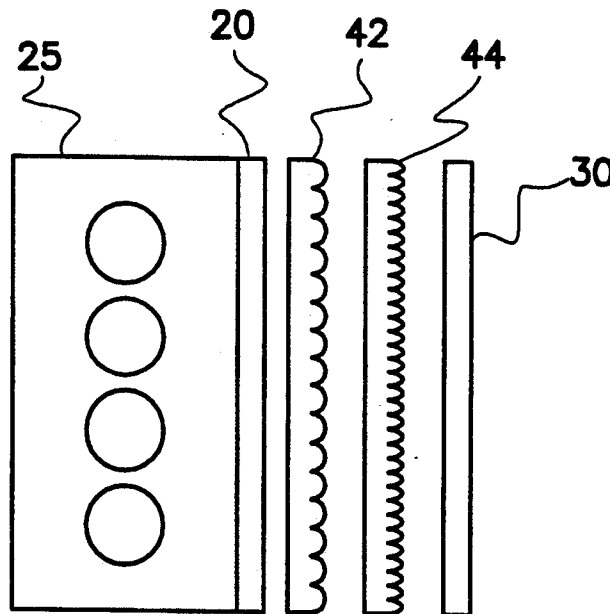


Fig. 1
PRIOR ART

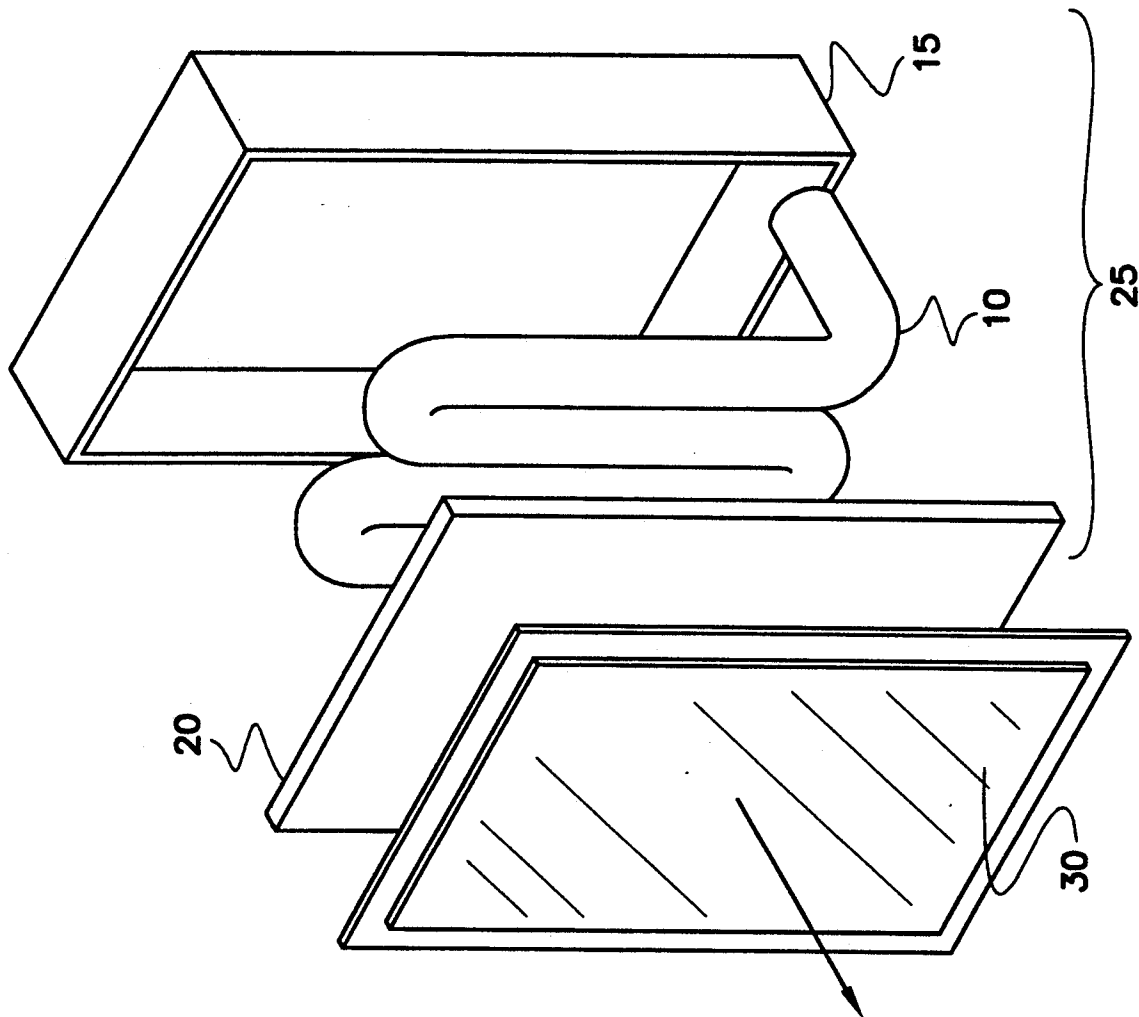
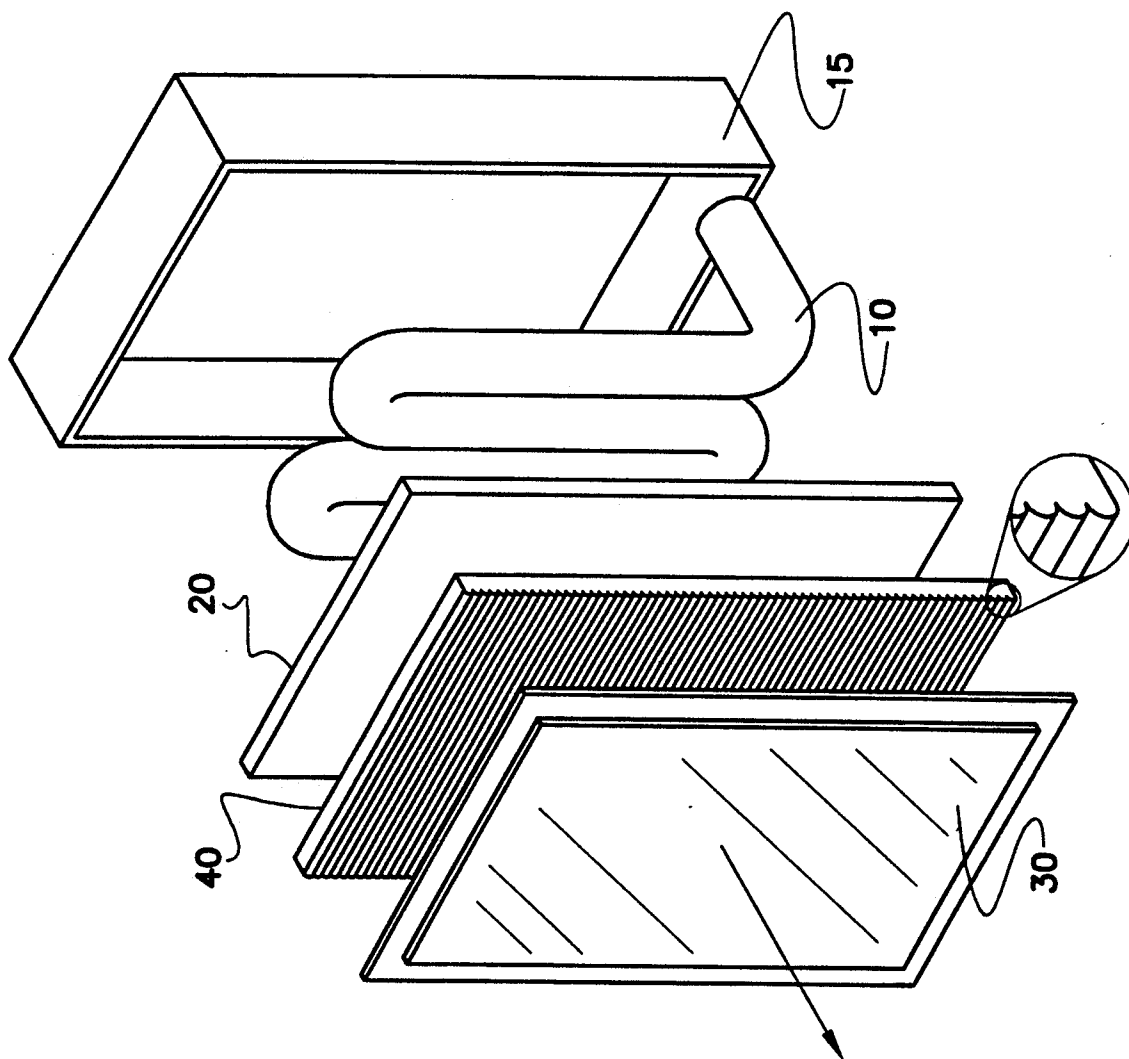


Fig. 2



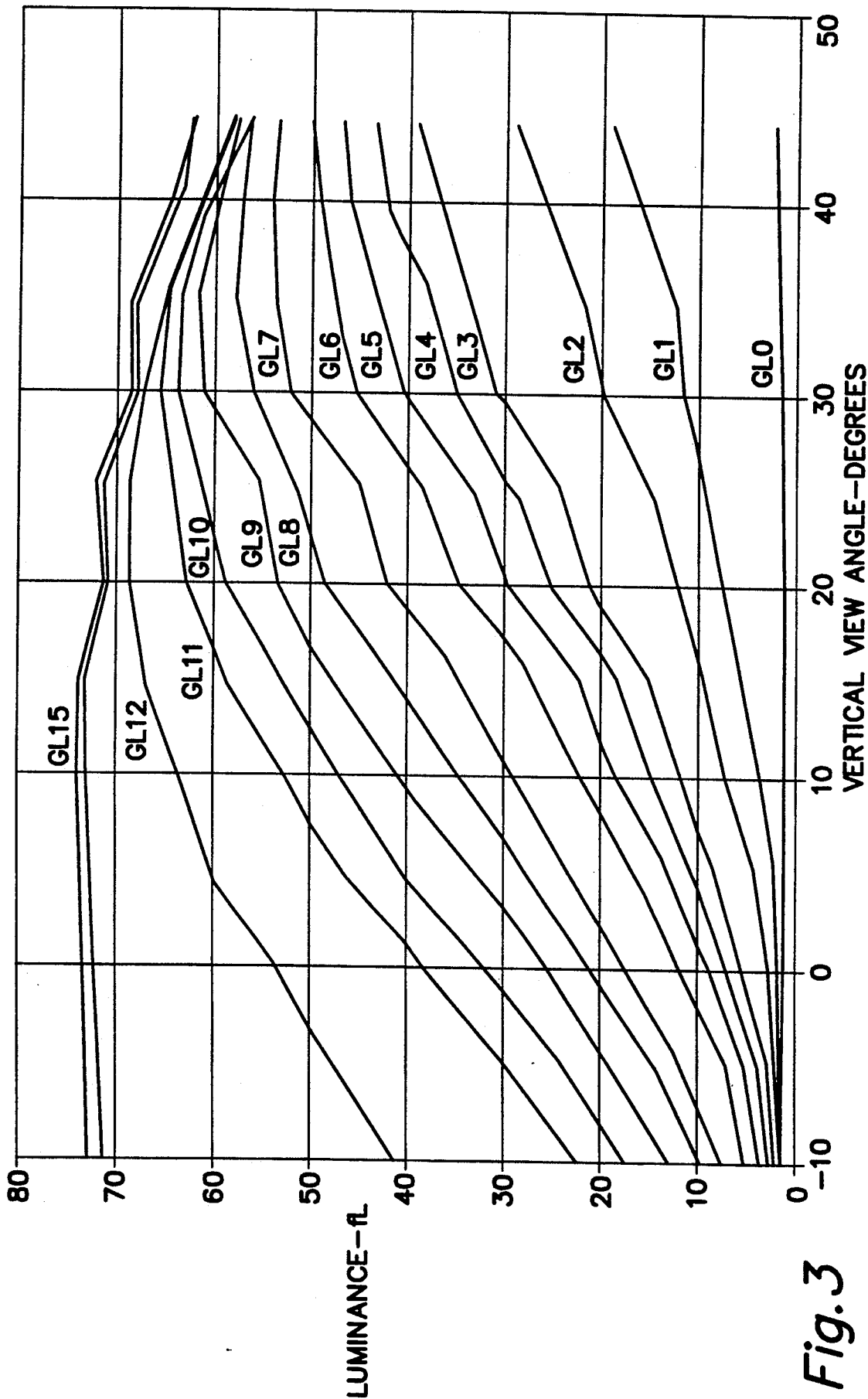


Fig. 3

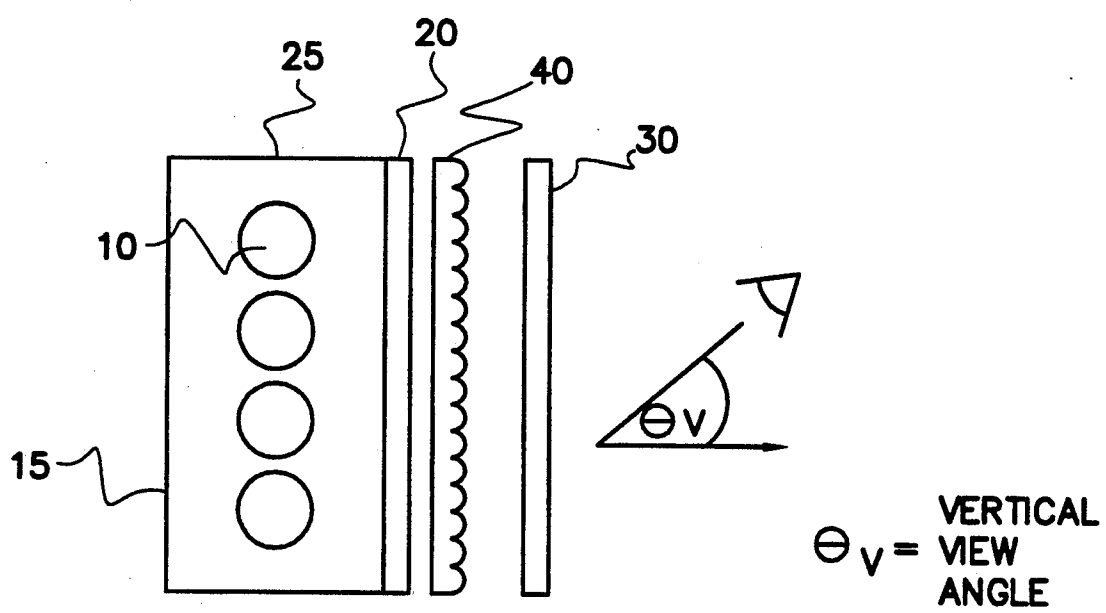


Fig. 4A

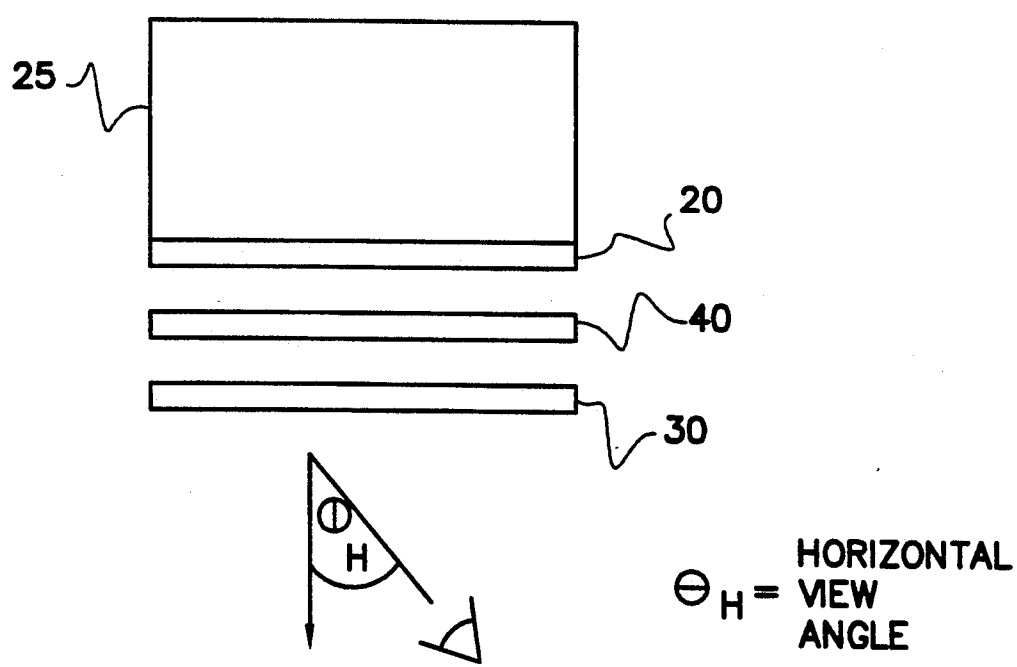


Fig. 4B

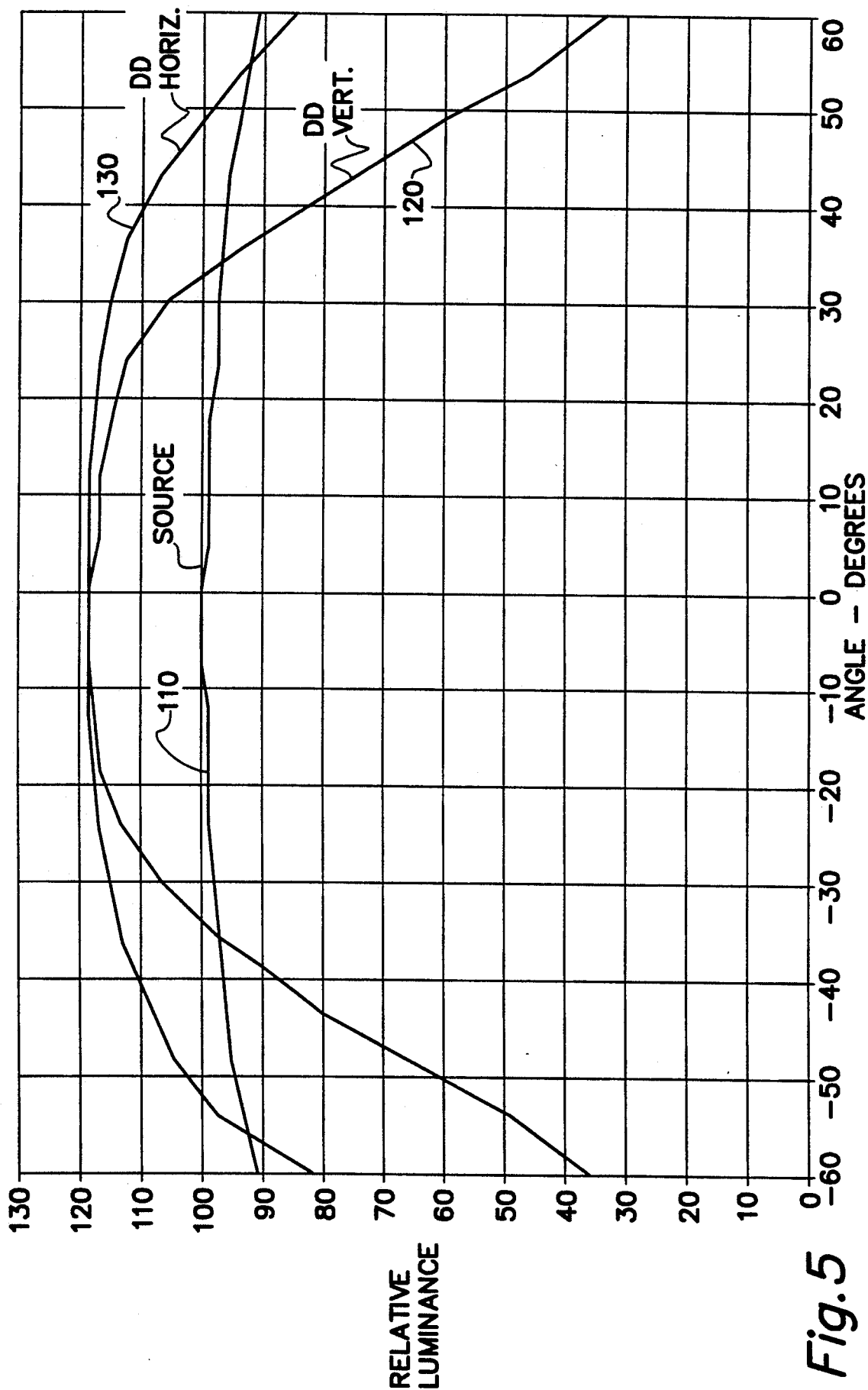
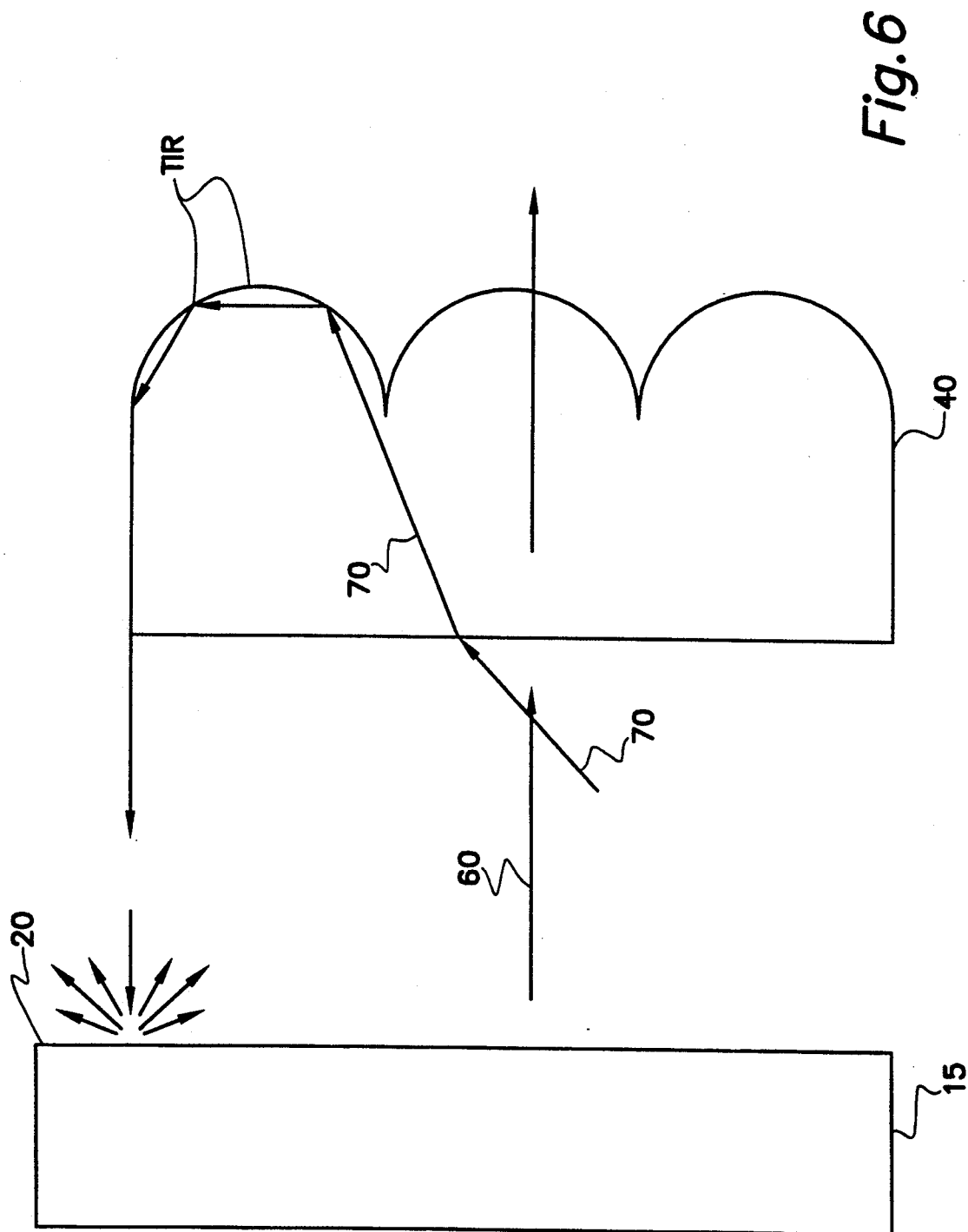


Fig. 5



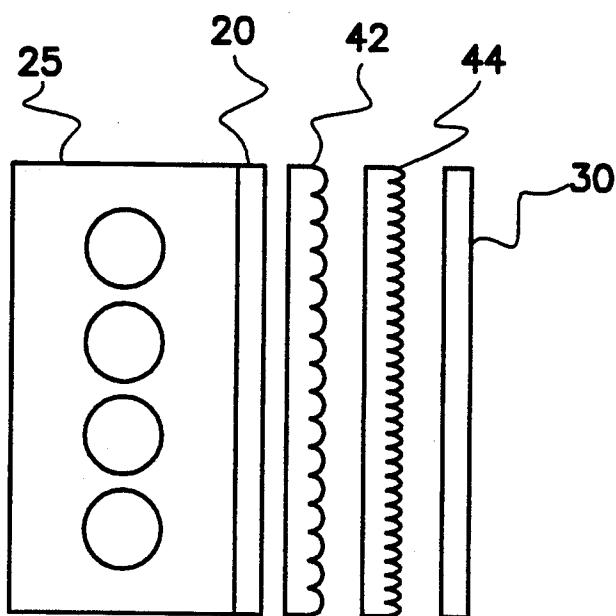


Fig. 7

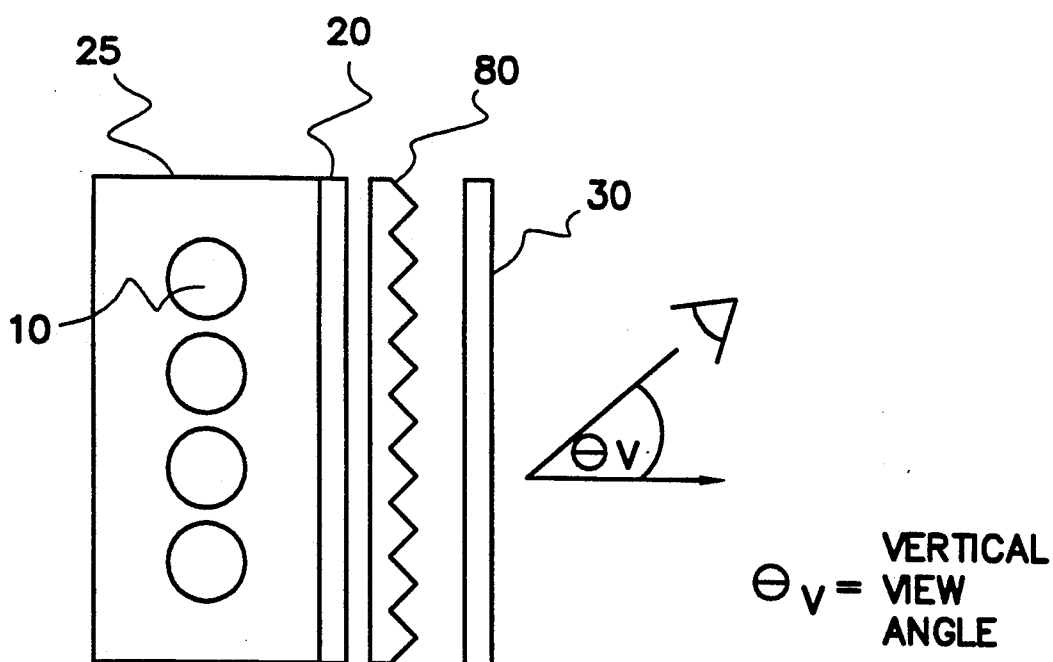


Fig. 10

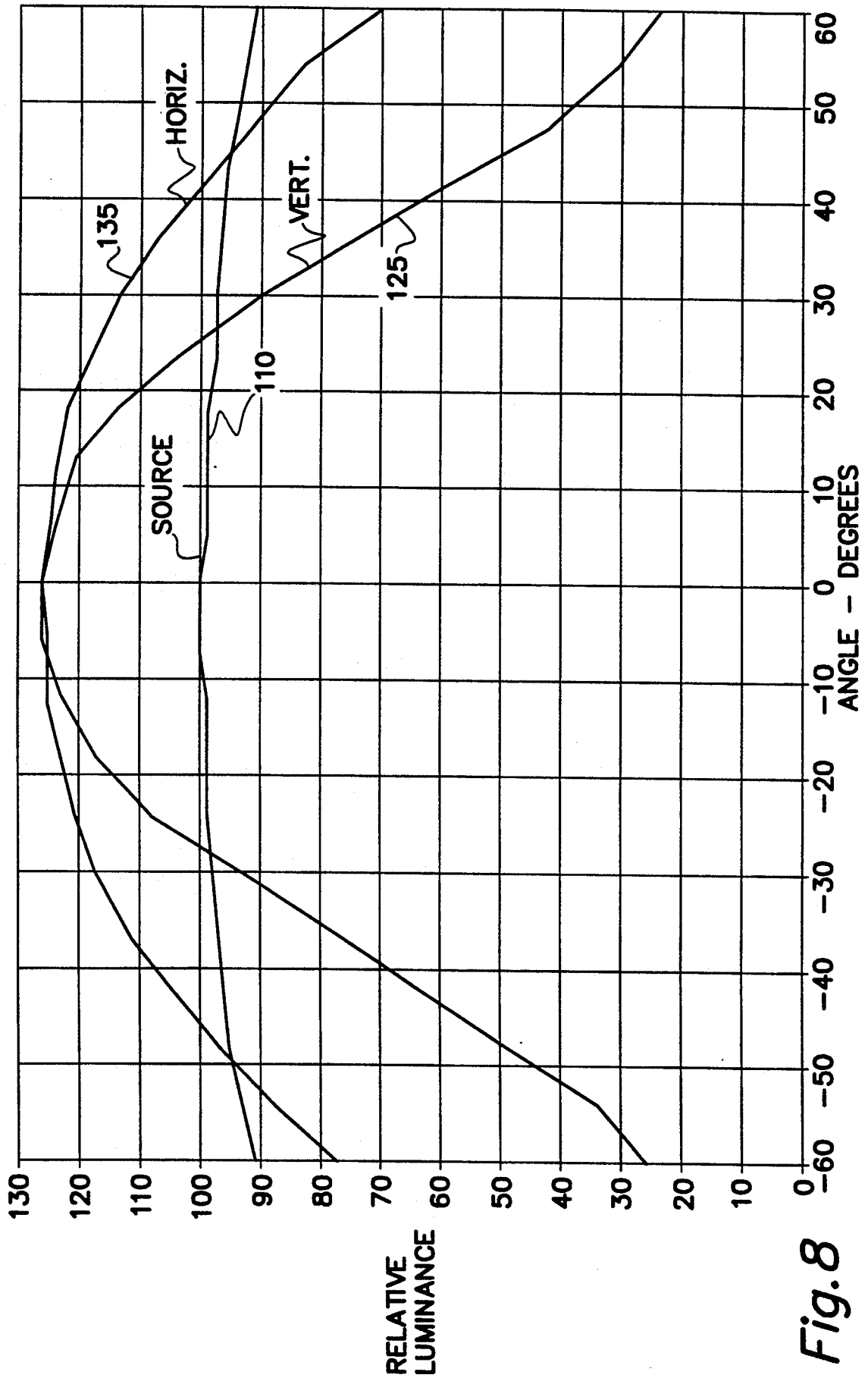


Fig. 8

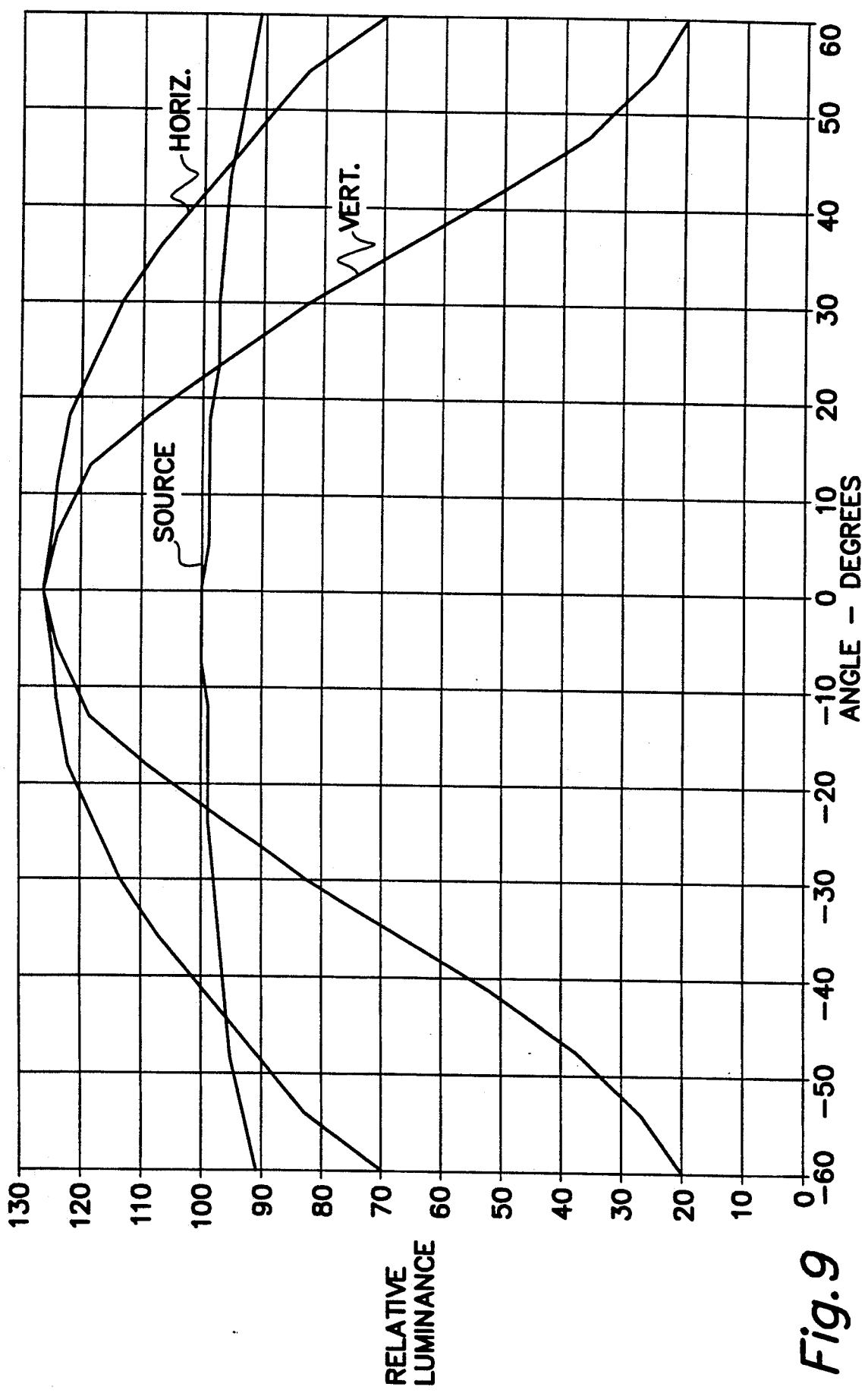


Fig. 9

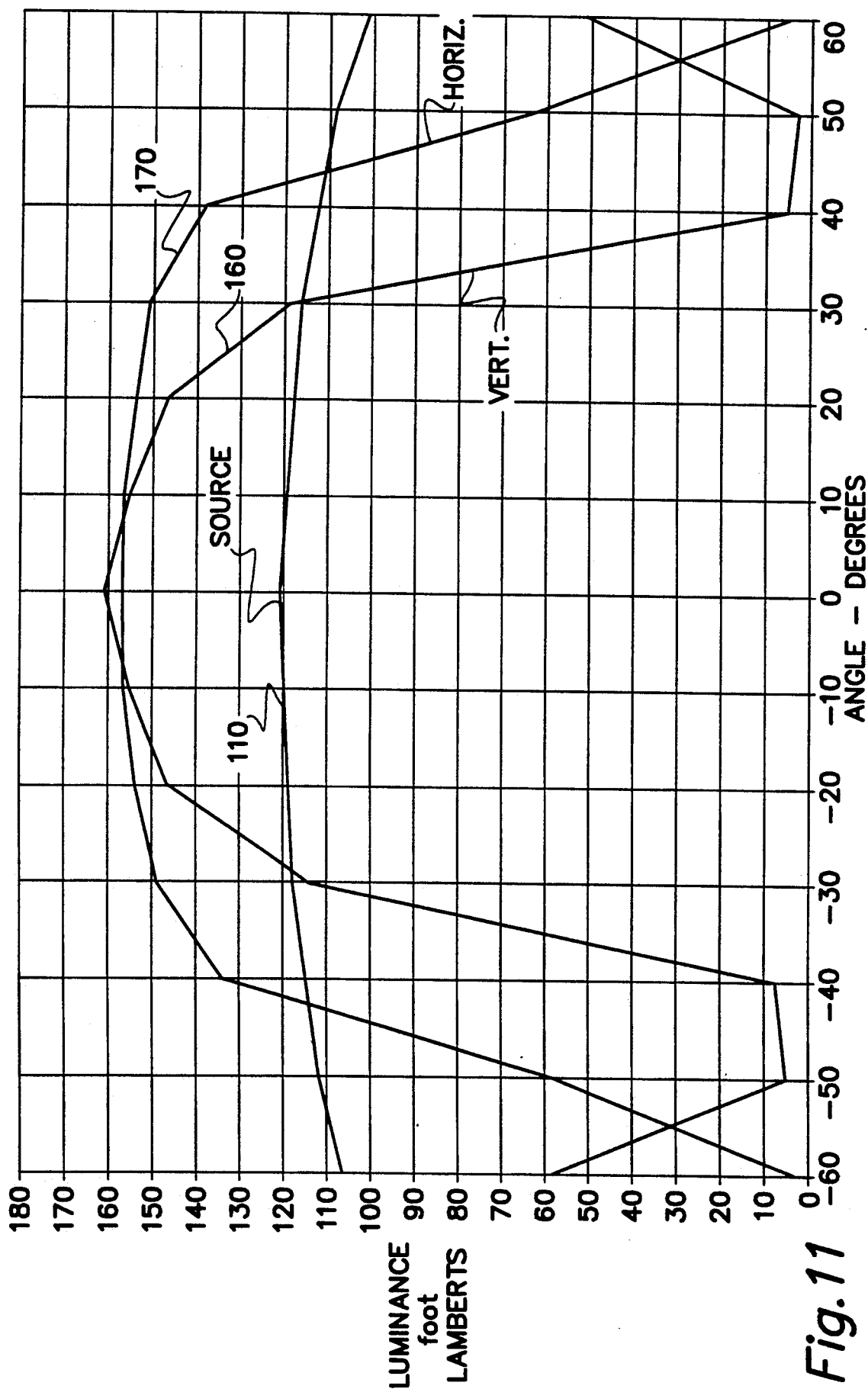
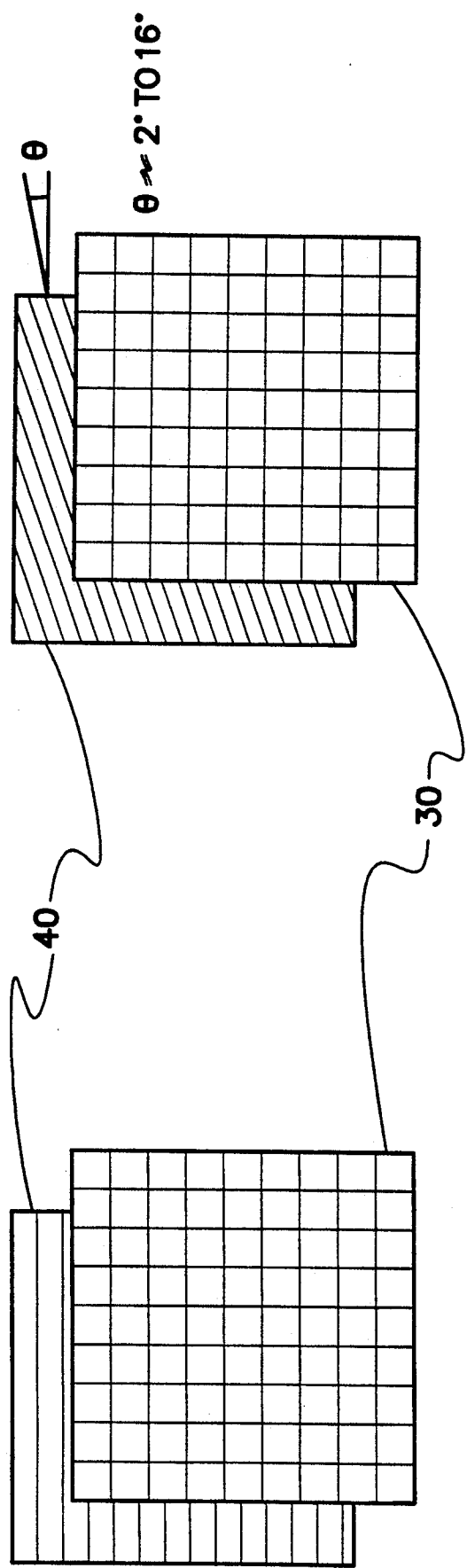


Fig. 11



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DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY

BACKGROUND OF THE INVENTION

This invention relates in general to flat panel liquid crystal displays and, more particularly, to a liquid crystal display (LCD) having a directional diffuser to provide a tailored variation of luminance with viewing angle.

There are commercially available liquid crystal displays for use in various applications, including for example aircraft cockpit displays. However, a typical characteristic of the liquid crystal panel used therein is a wide variation of the light transmission of the liquid crystal panel with viewing angle, especially the vertical viewing angle. This results in gray-scale errors and off-state errors with viewing angle. That is to say, the brightness of certain areas of the display when viewed at angles above or below a vertical viewing angle normal to the display surface, may be substantially different than the brightness of those areas when viewed at an angle normal to the display surface. This variation of brightness or luminance with viewing angle is generally undesirable and particularly undesirable in those cases where the information being displayed on the liquid crystal display is critical to an operation such as controlling or navigating an aircraft.

In addition, a typical diffuser used to provide a light source for backlighting a typical liquid crystal display ordinarily provides a constant luminance with viewing angle and therefore provides the same amount of energy for any given viewing angle of the display. In certain applications, such as for example an aircraft cockpit, the typical vertical viewing angle is fixed within a relatively narrow range and it would therefore be desirable to concentrate a higher percentage of the energy from the light source within a particular range of viewing angles.

It would therefore be desirable to provide a directional diffuser for use with a liquid crystal display to provide a tailored variation of luminance with viewing angle while also providing a concentration of the light energy from the light source within a predetermined range of viewing angles.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a directional diffuser element for a liquid crystal display to provide a tailored variation of luminance with viewing angle.

It is a further object of the present invention to provide a liquid crystal display having less variation of intermediate gray-level luminance with viewing angle.

It is still further an object of the present invention to provide a liquid crystal display combining the above features to provide a higher concentration of light energy, and therefore increased luminance, within a particular range of viewing angles thereby providing a more efficient use of light energy available from a light source.

The foregoing and other objects are achieved in the present invention wherein there is provided a liquid crystal display apparatus comprising a light source, a liquid crystal planar array of pixels for creating an image by controlling the amount of light allowed to pass through each of the pixels, and one or more directional diffuser lens arrays disposed between the light

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source and the liquid crystal array for providing a tailored variation of luminance from the liquid crystal display as a function of vertical viewing angle.

BRIEF DESCRIPTION OF THE DRAWINGS

The above mentioned and other features and objects of the present invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of alternative embodiments of the invention taken in conjunction with the accompanying drawings wherein:

FIG. 1 is an exploded view of a typical prior art backlit liquid crystal display;

FIG. 2 is an exploded view of the liquid crystal display of the present invention, having a directional diffuser lens array;

FIG. 3 illustrates a typical prior art LCD gray-level response showing the variation of luminance with vertical viewing angle;

FIGS. 4A and 4B show cross sectional side and top views of a typical assembly including the lens array of the present invention;

FIG. 5 illustrates the variation of luminance with viewing angle- for a light source alone and a light source combined with a single lens array;

FIG. 6 illustrates the path of various light rays when striking the lens array at various angles;

FIG. 7 is a cross sectional view of a preferred embodiment of the present invention with two lens arrays;

FIG. 8 illustrates the variation of luminance with viewing angle for the dual lens array configuration;

FIG. 9 illustrates the variation of luminance with viewing angle for a triple lens array configuration;

FIG. 10 is a cross sectional view of a configuration utilizing a triangular shaped lens array;

FIG. 11 illustrates the variation of luminance with viewing angle for the triangular shaped lens array; and

FIG. 12 shows the angular rotation of the lens array with respect to the LCD matrix array to eliminate residual moire effects.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to FIG. 1 there is shown a cross section of a typical prior art liquid crystal display apparatus including backlight array 25 comprising lamp 10, rear reflecting surface 15 and lambertian diffuser 20. The backlight array provides a source of light which impinges on liquid crystal panel 30 comprised of a number of individual liquid crystal elements which are alternately energized in order to form a desired pattern or image for viewing from the front of the liquid crystal display.

While this typical prior art liquid crystal panel may be adequate for certain applications where the normal viewing angle is more or less at an angle normal to the display surface, this display is not optimum for applications wherein the typical viewing angle is other than at an angle normal to the display surface. This prior art display exhibits a relatively wide variation of light transmission with viewing angle, especially the vertical viewing angle. As illustrated in FIG. 3 this variation also changes with the level of lumination for various gray-levels or intermediate intensities for a given display.

As can be seen in the curves of FIG. 3, the luminance emitted from the lower gray-levels of the LCD system increases significantly with increasing vertical viewing angle. This variation presents an undesirably large luminance increase with angle when the information being presented is low-level luminance information, such as for avionics applications including weather radar or attitude director indicator presentations. As a pilot viewing the display moves his vertical perspective, or his viewing angle, higher above a normal angle to the display (larger vertical viewing angles), he observes a low luminance field increase significantly in luminance, thereby causing confusion in interpretation of critical display information.

In addition, the lambertian diffuser of the typical prior art display, element 20 of FIG. 1, provides for a nearly equal luminance in all angular viewing directions. In most applications a 180° field of view in both horizontal and vertical directions is not required. It would therefore be more energy efficient if a substantial portion of the light energy could be redirected so as to be concentrated in the viewing angles of interest for a particular application.

The apparatus of the present invention includes the backlight array and liquid crystal of the prior art as shown in FIG. 1 with the addition of a lens array 40 inserted between the lambertian diffuser 20 of the prior art and liquid crystal display panel 30, as shown in FIG. 2. It was found that by inserting a directional diffuser consisting of a cylindrical lens array 40 between the lambertian diffuser and the liquid crystal panel that both of the desired effects could be accomplished. That is, the overall light energy is concentrated within a desired range of viewing angles and the variation of luminance with viewing angle is tailored to offset that which is obtained through the liquid crystal display alone.

For example, FIG. 5 illustrates that with the insertion of lens array 40 as shown in FIGS. 4A and 4B, the overall luminance has increased approximately 20 percent within a range from -20° to +20° viewing angle and the desired decrease in luminance with increased vertical viewing angle is obtained between approximately +10° and +35° of vertical viewing angle. Curve 110 of FIG. 5 illustrates the variation of luminance with viewing angle for the lambertian light source only, in both the horizontal and vertical angles while curves 120 and 130 respectively represent a variation of luminance with vertical and horizontal viewing angles for the backlight including lens array 40.

The effect which results from the insertion of the cylindrical lens array is explained by reference to FIG. 6 wherein there are shown light rays from the lambertian (having uniform luminance with angle) source diffuser impinging on the lens array from various angles. An air gap must be present at the interface of the lambertian diffuser and the lens array. The normal 4 percent loss per surface due to fresnel reflections is not incurred, because the surface reflections are returned to the diffuser and reflected again.

Those rays that are normal to the source diffuser but less than the critical angle within the lens array are passed through the lens array materially unobstructed, except for a small amount of surface reflection. Rays which enter at oblique angles and are greater than the critical angle of the lens array undergo total internal reflection at the inside of the lens surface as illustrated by ray tracing 70. These rays are reflected with no loss due to the total internal reflection effect around the lens

periphery. They exit the rear of the lens array and return to the source diffuser where they undergo a secondary diffuse reflection from the source diffuser.

However, because the source diffuser is not totally reflective, some of the returned rays are transmitted through the diffuser and are then reflected from the backlight enclosure surface 15 of FIG. 4A. Some fraction of these rays are reflected internally to exit the diffuser again. These reflected rays again have a lambertian distribution at the surface of lambertian diffuser 20. It is apparent from this interaction between the lens array and the backlight that rays which impinge close to the normal tend to be intensified while those rays which impinge at oblique angles undergo total internal reflection and are returned to the diffuser and diminished somewhat from this statistical process.

However, the roll off or variation with vertical viewing angle for this single directional diffuser cylindrical lens array was not sufficient to offset the effects of the liquid crystal display, and there were significant moire patterns caused by the interference between the lens array and the display panel wherein the lens array contained 142 lenses per inch and the display panel matrix had a spatial frequency resolution of 172 dots or pixels per inch.

For the desired specific implementation it was discovered that the adverse interaction producing moire patterns could be eliminated by including a second lens array with a different number of lenses per inch. The combination of the dual lenses increased the desired reduction in luminance with increased viewing angle, and in addition reduced or eliminated the moire patterns with the selection of an appropriate pitch, or number of lenses per inch, for the two lenses in question.

As illustrated in FIG. 7, one of the lens arrays 42 was selected to have a relatively coarse pitch with respect to that of the liquid crystal display and the second lens array 44 was selected to have a relatively fine pitch with respect to that of liquid crystal display. FIG. 8 illustrates again the relatively flat response of the lambertian source diffuser alone curve 110, and the increased roll off with vertical viewing angle of curve 125 as well as the corresponding variation of luminance with horizontal viewing angle as illustrated by curve 135 for the dual lens array of FIG. 8.

In general it was discovered that the addition of additional lens arrays caused a steeper or more rapid variation of the change in luminance with vertical viewing angle, which was desirable, but the corresponding change in luminance with variations in horizontal viewing angle also became steeper, which was not desirable for the particular application in question. For the particular application in question the preferred embodiment included two lens arrays in series which provided the best tradeoff of decrease in luminance with variation of vertical viewing angle, while not adversely affecting the variation in luminance with horizontal viewing angle.

In addition, since moire effects result when both of the lens arrays have the same spatial frequency, the rear array 42 should have a coarse resolution or low spatial frequency while the front lens array 44 should have a fine resolution or high spatial frequency. The lens arrays and the panel spatial frequencies should be selected to avoid integral multiples of the other. Thus the fine lens array should be as high a spatial frequency as is practical and should be a non integral multiple of the panel frequency. According to these guidelines the fine

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array frequency becomes approximately 2.5 times the display spatial frequency and the coarse array frequency should be approximately the fine array frequency divided by 3.5, 4.5, 5.5 or as required for the most convenient fabrication.

It was also discovered that the maximum increase in luminance was obtained using a triangular lens array having an included angle of 90° as illustrated in FIG. 10. This configuration resulted in a variation of luminance with vertical and horizontal viewing angles which was quite steep as illustrated by curves 160 and 170 of FIG. 11. Other lens array shapes may be selected as desired to obtain the required concentration of luminance and variation of luminance with vertical and horizontal viewing angle for a particular application.

Even though the spatial frequencies of the directional diffuser lens array and LCD panel have been selected to be greatly different and non-integer multiples, some visual banding effects or moire pattern effects may still be apparent to the viewer. This is especially true at off-axis viewing conditions. This residual moire can be removed by rotating the lens array 40 with the respect to the LCD array 30, as illustrated in FIG. 12. This rotation of the lens array by a few degrees (Typically 2 to 16 degrees) from the horizontal axis causes a small change in the effective spatial frequency difference of the two arrays and thereby eliminates the residual moire.

In addition to the angular redistribution of the light from the directional diffuser, the lens array also provides an additional diffusing effect, especially for any step variations in luminance that are parallel to (or nearly parallel to within a few degrees) the axis of the lens array. This allows the reduction of the thickness or optical density of the conventional diffuser while still achieving the same system luminance uniformity and masking of undesired spatial artifacts from the light source, but with higher luminance at the output.

While there have been described above the principals of invention in conjunction with several specific embodiments, it is to be clearly understood that these descriptions are made only by way of example and not as a limitation to the scope of the invention.

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We claim:

1. A display apparatus comprising:

a light source;

a liquid crystal panel mounted adjacent to said light source for receiving light from said light source; and

first and second lens arrays, each having a plurality of individual lenslets, disposed between said light source and said liquid crystal panel for providing a predetermined variation with viewing angle of light transmission from said light source through said lens arrays and said liquid crystal panel, wherein said liquid crystal panel comprises a plurality of pixels arranged in rows and columns, and wherein the number of rows of pixels per unit height, or pitch, of the liquid crystal panel is a first value; the number of lenslets per unit height, or pitch, of said first lens array is a second value which is less than said first value; and the number of lenslets per unit height, or pitch, of said second lens array is a third value which is greater than said first value.

2. A display apparatus in accordance with claim 1 wherein said third value is a non-integral multiple of said first value and is also a non-integral multiple of said second value.

3. A display apparatus comprising:

a light source;

a liquid crystal panel mounted adjacent to said light source for receiving light from said light source; and

first and second lens arrays, each having a plurality of individual lenslets, disposed between said light source and said liquid crystal panel for providing a predetermined variation with viewing angle of light transmission from said light source through said lens arrays and said liquid crystal panel, wherein at least one of said first and second lens arrays is rotated about an axis perpendicular to said liquid crystal panel in order to provide a slight misalignment between said lenslets and said liquid crystal panel.

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EXHIBIT B

FILE WRAPPER FOR U.S. PATENT

NO: 5,280,371

ISSUE DATE: JANUARY 18, 1994

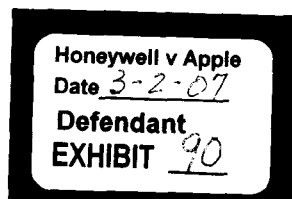
INVENTORS: RICHARD I. MCCARTNEY, JR.
DANIEL D. SYROID
KAREN E. JACHIMOWICZ

SERIAL NO: 07/911,547

FILING DATE: JULY 9, 1992

TITLE: DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY

REFERENCES CITED - SEE PAPERS #3, 5



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SERIAL NUMBER 911547 PATENT DATE JAN 18 1994 PATENT NUMBER 5280371

SERIAL NUMBER 07/911,547 FILING DATE 07/09/92 CLASS 359 SUBCLASS 000 GROUP PART UNIT 2504

APPLICANTS RICHARD I. MC CARTNEY JR., SCOTTSDALE, AZ; DANIEL D. SYROID, GLENDALE, AZ; KAREN E. JACHIMOWICZ, GOODYEAR, AZ.

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Foreign priority claimed 35 USC 119 conditions met	<input type="checkbox"/> yes <input checked="" type="checkbox"/> no	AS FILED	STATE OR COUNTRY AZ	SHEETS DRWGS. 12	TOTAL CLAIMS 9	INDEP. CLAIMS 1	FILING FEE RECEIVED \$630.00	ATTORNEY'S DOCKET NO. A6213491
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TITLE DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY

U.S. DEPT. of COMM., Pat. & TM Office - PTO-436L (rev. 10-78)

PARTS OF APPLICATION FILED SEPARATELY

NOTICE OF ALLOWANCE MAILED 7-19-93	PREPARED FOR ISSUE HUY MAI Assistant Examiner Annette Smith Docket Clerk	CLAIMS ALLOWED Total Claims 3 Print Claim 1
ISSUE FEE Amount Due \$1700 Date Paid 8-27-93	WILLIAM L. SIKES SUPERVISORY PATENT EXAMINER	DRAWING Sheets Drwg. 11 Figs. Drwg. 13 Print Fig. 7
Label Area	ISSUE CLASSIFICATION Class 359 Subclass 40	ISSUE BATCH NUMBER 098

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BAR CODE LABEL						U.S. PATENT APPLICATION	
SERIAL NUMBER		FILING DATE		CLASS		GROUP ART UNIT	
07/911,547		07/09/92		359		2504	
APPLICANT	RICHARD I. MC CARTNEY JR., SCOTTSDALE, AZ; DANIEL D. SYROID, GLENDALE, AZ; KAREN E. JACHIMOWICZ, GOODYEAR, AZ.						
	CONTINUING DATA*** VERIFIED _____						
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STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS	FILING FEE RECEIVED	ATTORNEY DOCKET NO.		
AZ	12	9	1	\$ 690.00	A6213491		
ADDRESS	DALE E. JEPSEN HONEYWELL INC. 21,111 N. 19TH AVENUE, DV9L PHOENIX, AZ 85027						
TITLE	DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY						
This is to certify that annexed hereto is a true copy from the records of the United States Patent and Trademark Office of the application as filed which is identified above. By authority of the COMMISSIONER OF PATENTS AND TRADEMARKS							
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<u>7/28/93 AS</u>	3. <u>Reg (3 months)</u>	<u>10/2/93</u>
<u>2/25/93</u>	4. <u>Reg Ext (1) / Amolt A</u>	<u>2/2/93</u>
<u>7/8/93 AS</u>	5. <u>Final Rejection (3 months)</u>	<u>5-10-93 MIN</u>
<u>7/8/93 AS</u>	6. <u>Reg Ext (1)</u>	<u>7/2/93</u>
<u>7/8/93 AS</u>	7. <u>Amolt B</u>	<u>7/2/93</u>
<u>7-16-93</u>	8. <u>INTERVIEW SUMMARY</u>	<u>7-16-93</u>
<u>7/19/93 AS</u>	9. <u>PTO-37 NOTICE OF ALLOWABILITY</u>	<u>7-19-93 AS</u>
<u>8/15/93</u>	10. <u>Formal Amalgam (1 sheet)</u>	<u>8/27/93</u>
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[73] Assignee: Honeywell Inc., Minneapolis, Minn.

[21] Appl. No.: 911,547

[22] Filed: Jul. 9, 1992

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[52] U.S. CL. 359/40; 359/69

[58] Field of Search 359/69, 40, 41

[56] References Cited

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IBM Corp., "Polarized backlight for liquid crystal display", IBM Technical Disclosure Bulletin, vol. 33, No. 1B, Jun. 1990, pp. 143-144.

Primary Examiner—William L. Sikes

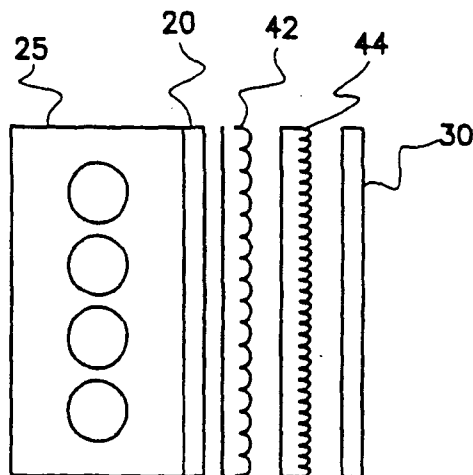
Assistant Examiner—Huy Mai

Attorney, Agent, or Firm—Dale E. Jepsen; A. Medved

[57] ABSTRACT

A display apparatus including a light source, a liquid crystal panel, and one or more directional diffuser lens arrays disposed therebetween provides a tailored variation of luminance with viewing angle, a uniform variation of luminance with viewing angle within a first predetermined range of viewing angles and a concentration of light energy within a second predetermined range of viewing angles.

3 Claims, 11 Drawing Sheets



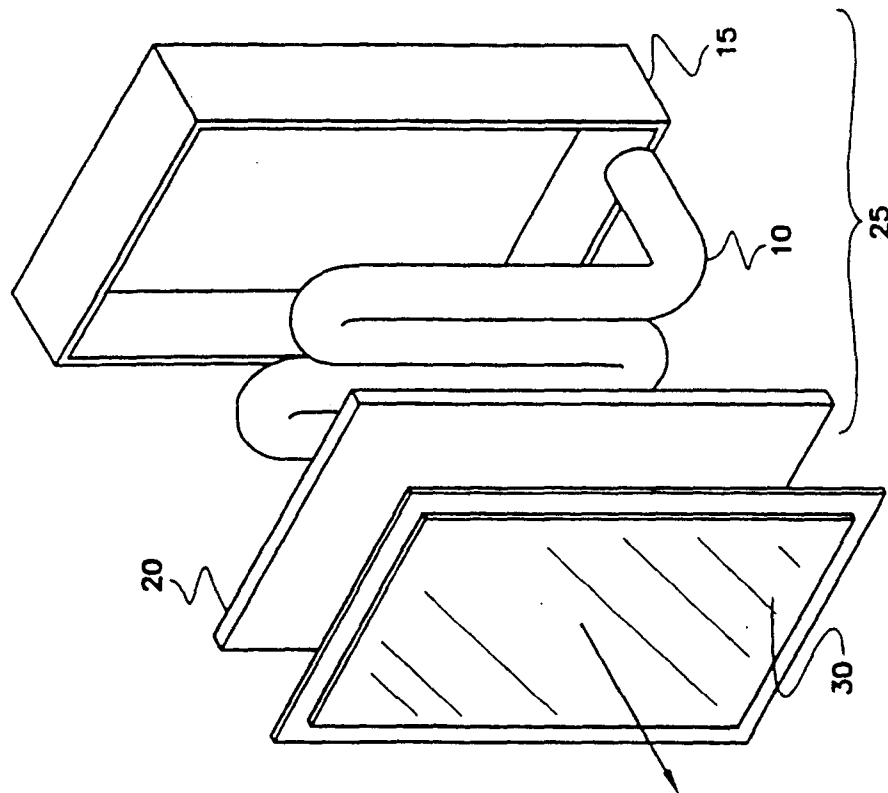
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Fig. 1
PRIOR ART



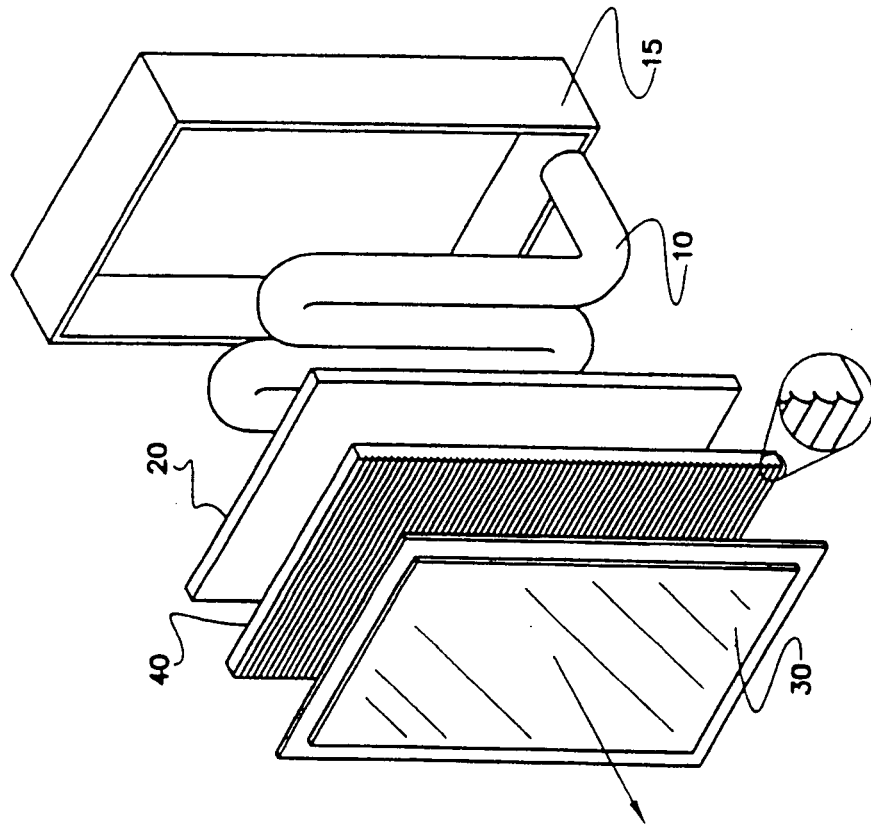
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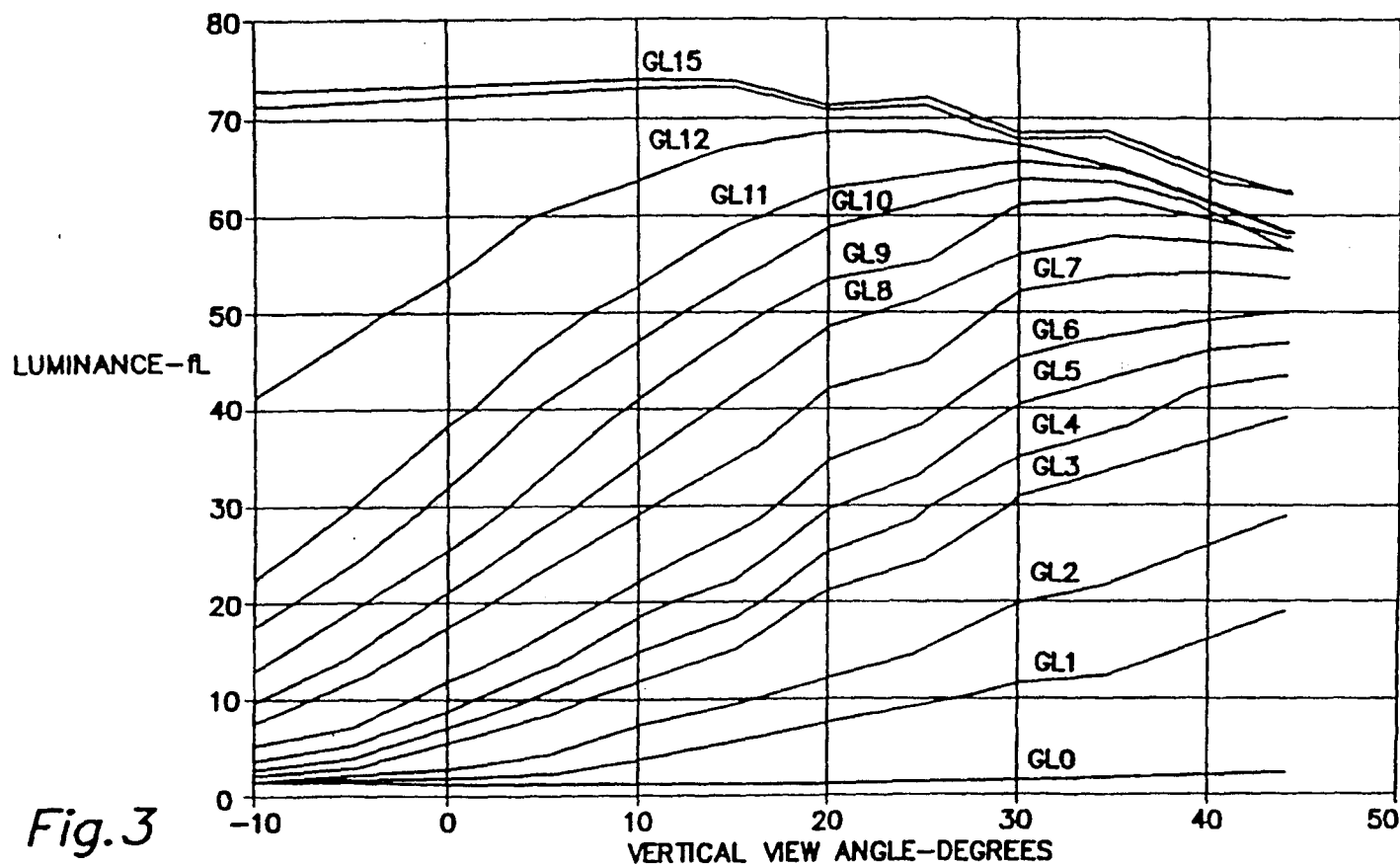
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Fig. 2





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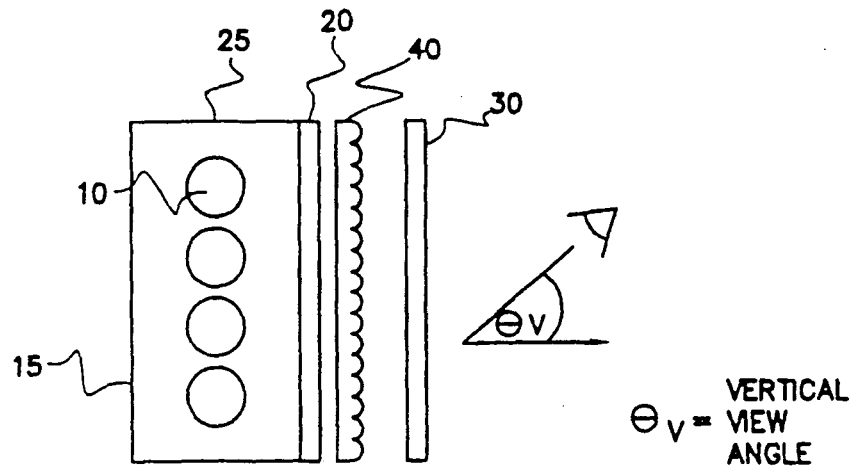


Fig. 4A

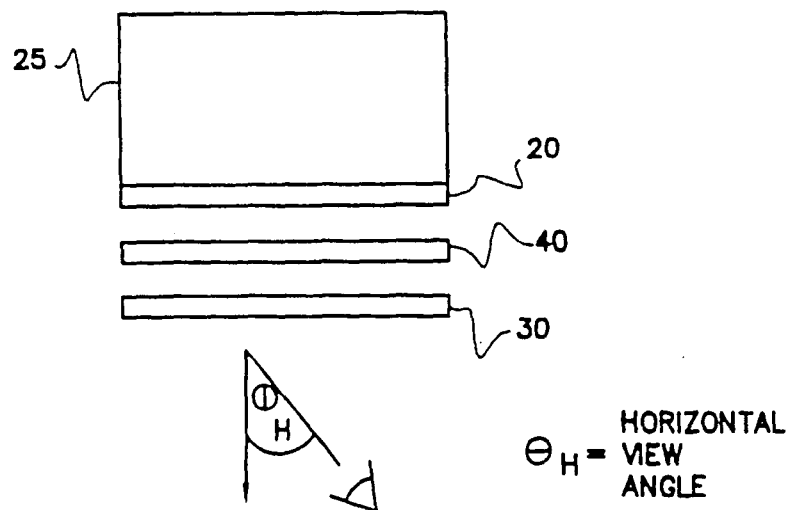


Fig. 4B

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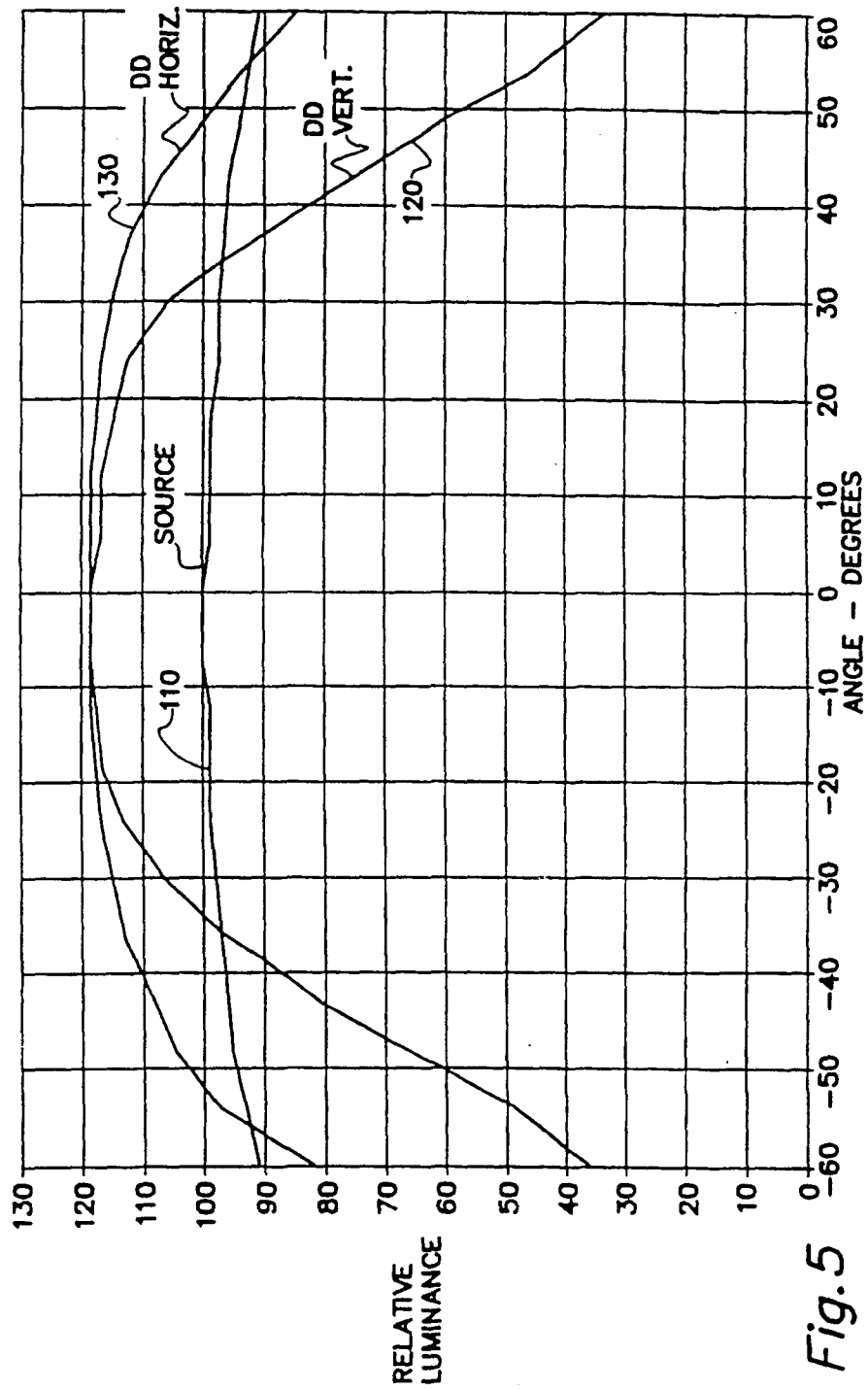


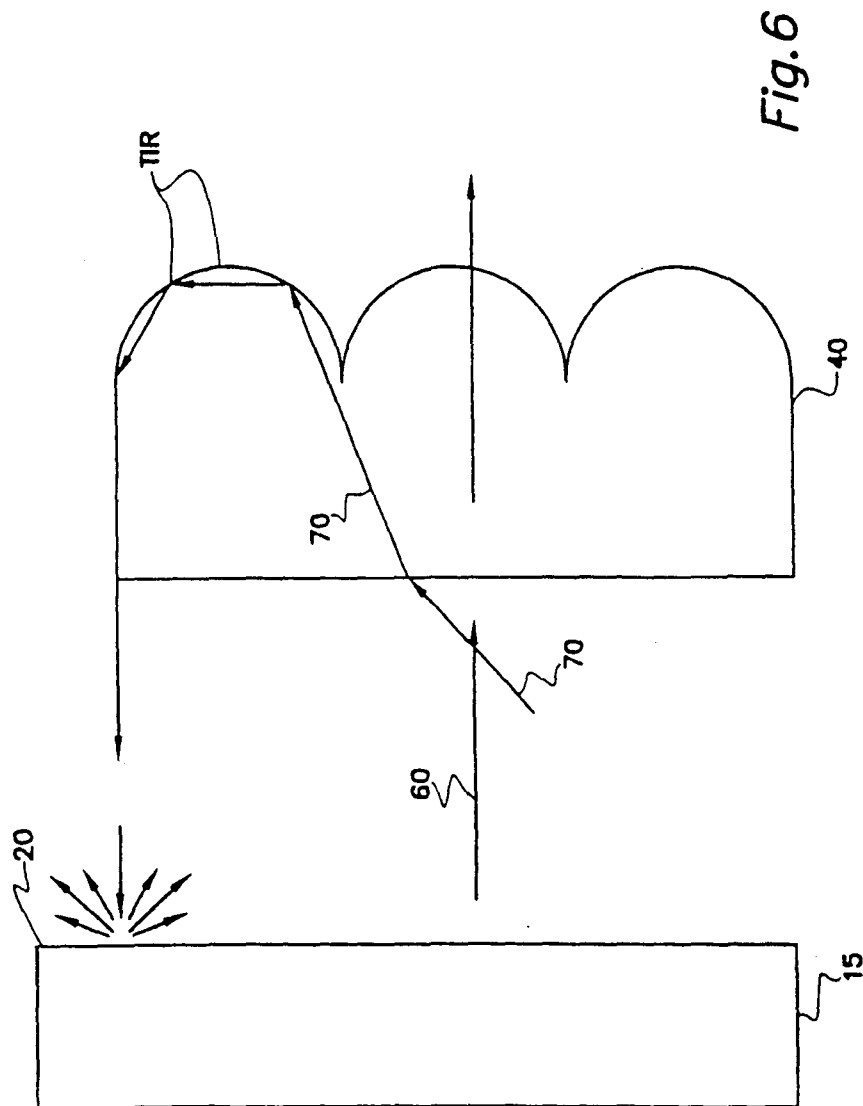
Fig. 5

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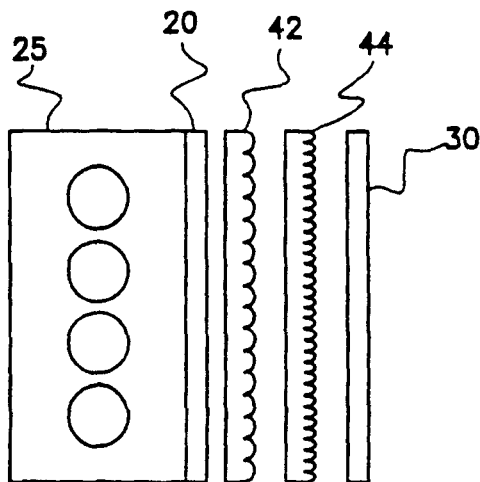


Fig. 7

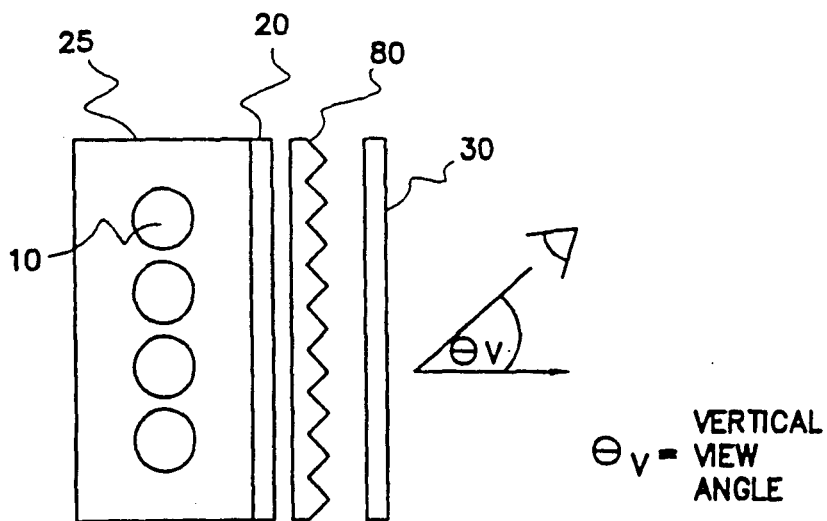


Fig. 10

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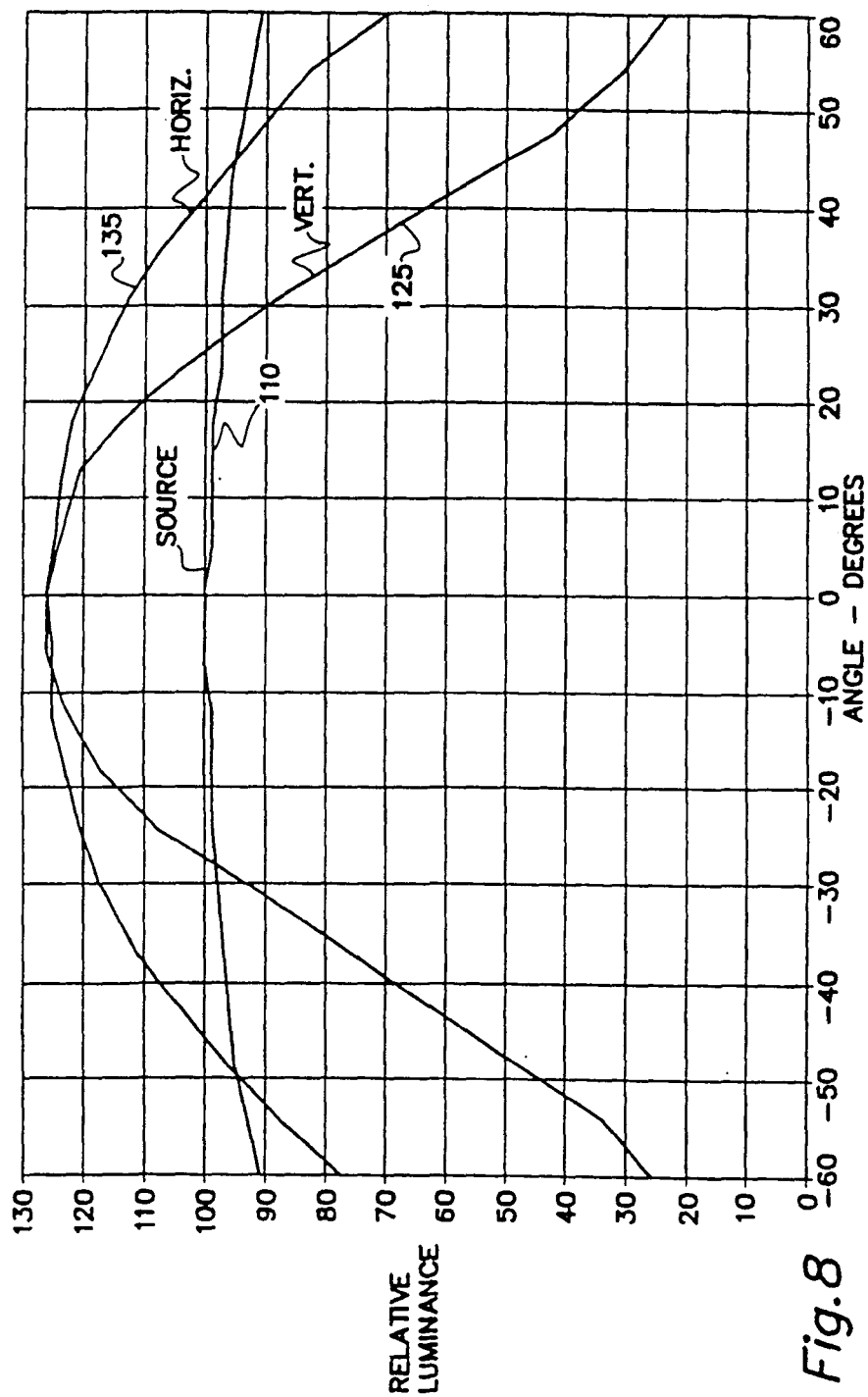


Fig. 8

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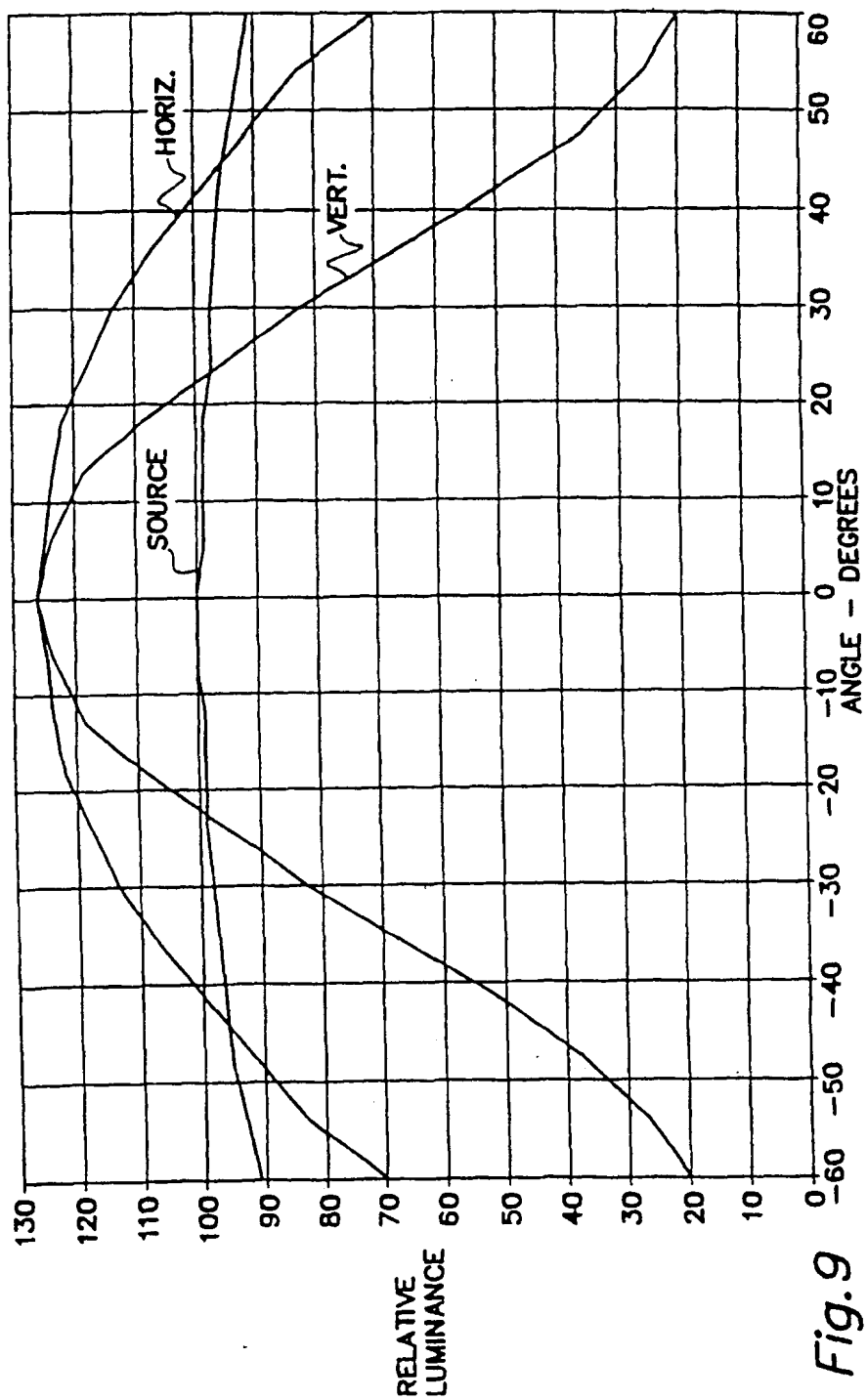


Fig. 9

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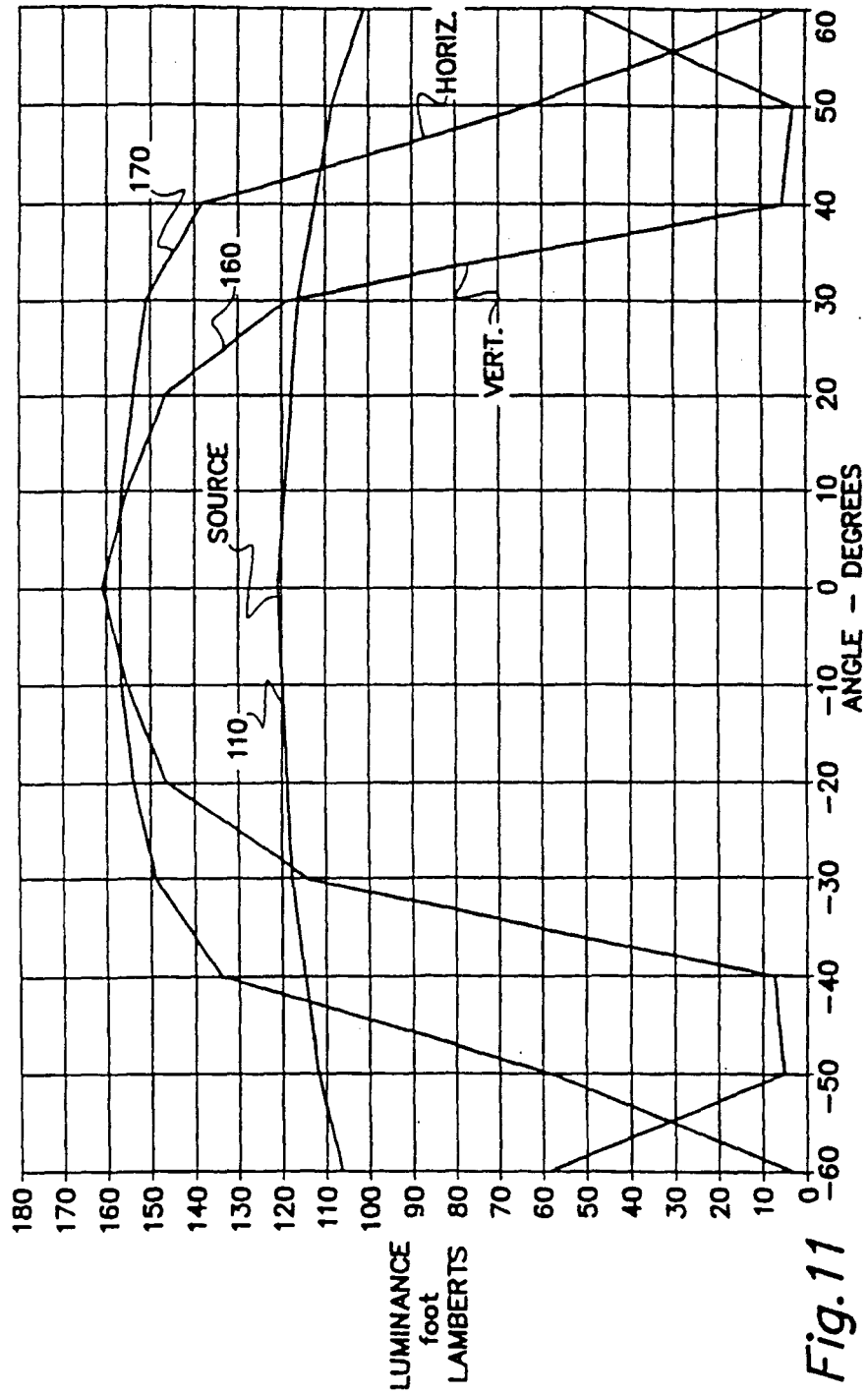


Fig. 11

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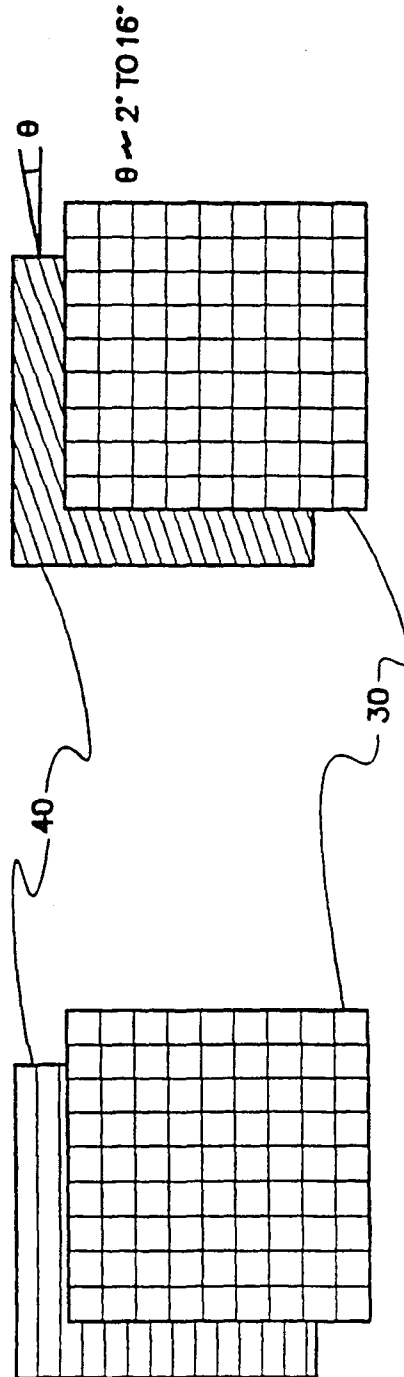


Fig. 12

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DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY

BACKGROUND OF THE INVENTION

This invention relates in general to flat panel liquid crystal displays and, more particularly, to a liquid crystal display (LCD) having a directional diffuser to provide a tailored variation of luminance with viewing angle.

There are commercially available liquid crystal displays for use in various applications, including for example aircraft cockpit displays. However, a typical characteristic of the liquid crystal panel used therein is a wide variation of the light transmission of the liquid crystal panel with viewing angle, especially the vertical viewing angle. This results in gray-scale errors and off-state errors with viewing angle. That is to say, the brightness of certain areas of the display when viewed at angles above or below a vertical viewing angle normal to the display surface, may be substantially different than the brightness of those areas when viewed at an angle normal to the display surface. This variation of brightness or luminance with viewing angle is generally undesirable and particularly undesirable in those cases where the information being displayed on the liquid crystal display is critical to an operation such as controlling or navigating an aircraft.

In addition, a typical diffuser used to provide a light source for backlighting a typical liquid crystal display ordinarily provides a constant luminance with viewing angle and therefore provides the same amount of energy for any given viewing angle of the display. In certain applications, such as for example an aircraft cockpit, the typical vertical viewing angle is fixed within a relatively narrow range and it would therefore be desirable to concentrate a higher percentage of the energy from the light source within a particular range of viewing angles.

It would therefore be desirable to provide a directional diffuser for use with a liquid crystal display to provide a tailored variation of luminance with viewing angle while also providing a concentration of the light energy from the light source within a predetermined range of viewing angles.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a directional diffuser element for a liquid crystal display to provide a tailored variation of luminance with viewing angle.

It is a further object of the present invention to provide a liquid crystal display having less variation of intermediate gray-level luminance with viewing angle.

It is still further an object of the present invention to provide a liquid crystal display combining the above features to provide a higher concentration of light energy, and therefore increased luminance, within a particular range of viewing angles thereby providing a more efficient use of light energy available from a light source.

The foregoing and other objects are achieved in the present invention wherein there is provided a liquid crystal display apparatus comprising a light source, a liquid crystal planar array of pixels for creating an image by controlling the amount of light allowed to pass through each of the pixels, and one or more directional diffuser lens arrays disposed between the light

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source and the liquid crystal array for providing a tailored variation of luminance from the liquid crystal display as a function of vertical viewing angle.

BRIEF DESCRIPTION OF THE DRAWINGS

The above mentioned and other features and objects of the present invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of alternative embodiments of the invention taken in conjunction with the accompanying drawings wherein:

FIG. 1 is an exploded view of a typical prior art backlit liquid crystal display;

FIG. 2 is an exploded view of the liquid crystal display of the present invention, having a directional diffuser lens array;

FIG. 3 illustrates a typical prior art LCD gray-level response showing the variation of luminance with vertical viewing angle;

FIGS. 4A and 4B show cross sectional side and top views of a typical assembly including the lens array of the present invention;

FIG. 5 illustrates the variation of luminance with viewing angle for a light source alone and a light source combined with a single lens array;

FIG. 6 illustrates the path of various light rays when striking the lens array at various angles;

FIG. 7 is a cross sectional view of a preferred embodiment of the present invention with two lens arrays;

FIG. 8 illustrates the variation of luminance with viewing angle for the dual lens array configuration;

FIG. 9 illustrates the variation of luminance with viewing angle for a triple lens array configuration;

FIG. 10 is a cross sectional view of a configuration utilizing a triangular shaped lens array;

FIG. 11 illustrates the variation of luminance with viewing angle for the triangular shaped lens array; and

FIG. 12 shows the angular rotation of the lens array with respect to the LCD matrix array to eliminate residual moire effects.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to FIG. 1 there is shown a cross section of a typical prior art liquid crystal display apparatus including backlight array 25 comprising lamp 10, rear reflecting surface 15 and lambertian diffuser 20. The backlight array provides a source of light which impinges on liquid crystal panel 30 comprised of a number of individual liquid crystal elements which are alternately energized in order to form a desired pattern or image for viewing from the front of the liquid crystal display.

While this typical prior art liquid crystal panel may be adequate for certain applications where the normal viewing angle is more or less at an angle normal to the display surface, this display is not optimum for applications wherein the typical viewing angle is other than at an angle normal to the display surface. This prior art display exhibits a relatively wide variation of light transmission with viewing angle, especially the vertical viewing angle. As illustrated in FIG. 3 this variation also changes with the level of luminance for various gray-levels or intermediate intensities for a given display.

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As can be seen in the curves of FIG. 3, the luminance emitted from the lower gray-levels of the LCD system increases significantly with increasing vertical viewing angle. This variation presents an undesirably large luminance increase with angle when the information being presented is low-level luminance information, such as for avionics applications including weather radar or attitude director indicator presentations. As a pilot viewing the display moves his vertical perspective, or his viewing angle, higher above a normal angle to the display (larger vertical viewing angles), he observes a low luminance field increase significantly in luminance, thereby causing confusion in interpretation of critical display information.

In addition, the lambertian diffuser of the typical prior art display, element 20 of FIG. 1, provides for a nearly equal luminance in all angular viewing directions. In most applications a 180° field of view in both horizontal and vertical directions is not required. It would therefore be more energy efficient if a substantial portion of the light energy could be redirected so as to be concentrated in the viewing angles of interest for a particular application.

The apparatus of the present invention includes the backlight array and liquid crystal of the prior art as shown in FIG. 1 with the addition of a lens array 40 inserted between the lambertian diffuser 20 of the prior art and liquid crystal display panel 30, as shown in FIG. 2. It was found that by inserting a directional diffuser consisting of a cylindrical lens array 40 between the lambertian diffuser and the liquid crystal panel that both of the desired effects could be accomplished. That is, the overall light energy is concentrated within a desired range of viewing angles and the variation of luminance with viewing angle is tailored to offset that which is obtained through the liquid crystal display alone.

For example, FIG. 5 illustrates that with the insertion of lens array 40 as shown in FIGS. 4A and 4B, the overall luminance has increased approximately 20 percent within a range from -20° to +20° viewing angle and the desired decrease in luminance with increased vertical viewing angle is obtained between approximately +10° and +35° of vertical viewing angle. Curve 110 of FIG. 5 illustrates the variation of luminance with viewing angle for the lambertian light source only, in both the horizontal and vertical angles while curves 120 and 130 respectively represent a variation of luminance with vertical and horizontal viewing angles for the backlight including lens array 40.

The effect which results from the insertion of the cylindrical lens array is explained by reference to FIG. 6 wherein there are shown light rays from the lambertian (having uniform luminance with angle) source diffuser impinging on the lens array from various angles. An air gap must be present at the interface of the lambertian diffuser and the lens array. The normal 4 percent loss per surface due to fresnel reflections is not incurred, because the surface reflections are returned to the diffuser and reflected again.

Those rays that are normal to the source diffuser but less than the critical angle within the lens array are passed through the lens array materially unobstructed, except for a small amount of surface reflection. Rays which enter at oblique angles and are greater than the critical angle of the lens array undergo total internal reflection at the inside of the lens surface as illustrated by ray tracing 70. These rays are reflected with no loss due to the total internal reflection effect around the lens

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periphery. They exit the rear of the lens array and return to the source diffuser where they undergo a secondary diffuse reflection from the source diffuser.

However, because the source diffuser is not totally reflective, some of the returned rays are transmitted through the diffuser and are then reflected from the backlight enclosure surface 15 of FIG. 4A. Some fraction of these rays are reflected internally to exit the diffuser again. These reflected rays again have a lambertian distribution at the surface of lambertian diffuser 20. It is apparent from this interaction between the lens array and the backlight that rays which impinge close to the normal tend to be intensified while those rays which impinge at oblique angles undergo total internal reflection and are returned to the diffuser and diminished somewhat from this statistical process.

However, the roll off or variation with vertical viewing angle for this single directional diffuser cylindrical lens array was not sufficient to offset the effects of the liquid crystal display, and there were significant moire patterns caused by the interference between the lens array and the display panel wherein the lens array contained 142 lenses per inch and the display panel matrix had a spatial frequency resolution of 172 dots or pixels per inch.

For the desired specific implementation it was discovered that the adverse interaction producing moire patterns could be eliminated by including a second lens array with a different number of lenses per inch. The combination of the dual lenses increased the desired reduction in luminance with increased viewing angle, and in addition reduced or eliminated the moire patterns with the selection of an appropriate pitch, or number of lenses per inch, for the two lenses in question.

As illustrated in FIG. 7, one of the lens arrays 42 was selected to have a relatively coarse pitch with respect to that of the liquid crystal display and the second lens array 44 was selected to have a relatively fine pitch with respect to that of liquid crystal display. FIG. 8 illustrates again the relatively flat response of the lambertian source diffuser alone curve 110, and the increased roll off with vertical viewing angle of curve 125 as well as the corresponding variation of luminance with horizontal viewing angle as illustrated by curve 135 for the dual lens array of FIG. 8.

In general it was discovered that the addition of additional lens arrays caused a steeper or more rapid variation of the change in luminance with vertical viewing angle, which was desirable, but the corresponding change in luminance with variations in horizontal viewing angle also became steeper, which was not desirable for the particular application in question. For the particular application in question the preferred embodiment included two lens arrays in series which provided the best tradeoff of decrease in luminance with variation of vertical viewing angle, while not adversely affecting the variation in luminance with horizontal viewing angle.

In addition, since moire effects result when both of the lens arrays have the same spatial frequency, the rear array 42 should have a coarse resolution or low spatial frequency while the front lens array 44 should have a fine resolution or high spatial frequency. The lens arrays and the panel spatial frequencies should be selected to avoid integral multiples of the other. Thus the fine lens array should be as high a spatial frequency as is practical and should be a non integral multiple of the panel frequency. According to these guidelines the fine

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array frequency becomes approximately 2.5 times the display spatial frequency and the coarse array frequency should be approximately the fine array frequency divided by 3.5, 4.5, 5.5 or as required for the most convenient fabrication.

It was also discovered that the maximum increase in luminance was obtained using a triangular lens array having an included angle of 90° as illustrated in FIG. 10. This configuration resulted in a variation of luminance with vertical and horizontal viewing angles which was quite steep as illustrated by curves 160 and 170 of FIG. 11. Other lens array shapes may be selected as desired to obtain the required concentration of luminance and variation of luminance with vertical and horizontal viewing angle for a particular application.

Even though the spatial frequencies of the directional diffuser lens array and LCD panel have been selected to be greatly different and non-integer multiples, some visual banding effects or moire pattern effects may still be apparent to the viewer. This is especially true at off-axis viewing conditions. This residual moire can be removed by rotating the lens array 40 with the respect to the LCD array 30, as illustrated in FIG. 12. This rotation of the lens array by a few degrees (Typically 2 to 16 degrees) from the horizontal axis causes a small change in the effective spatial frequency difference of the two arrays and thereby eliminates the residual moire.

In addition to the angular redistribution of the light from the directional diffuser, the lens array also provides an additional diffusing effect, especially for any step variations in luminance that are parallel to (or nearly parallel to within a few degrees) the axis of the lens array. This allows the reduction of the thickness or optical density of the conventional diffuser while still achieving the same system luminance uniformity and masking of undesired spatial artifacts from the light source, but with higher luminance at the output.

While there have been described above the principals of invention in conjunction with several specific embodiments, it is to be clearly understood that these descriptions are made only by way of example and not as a limitation to the scope of the invention.

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We claim:

1. A display apparatus comprising:

a light source;

a liquid crystal panel mounted adjacent to said light source for receiving light from said light source; and

first and second lens arrays, each having a plurality of individual lenslets, disposed between said light source and said liquid crystal panel for providing a predetermined variation with viewing angle of light transmission from said light source through said lens arrays and said liquid crystal panel, wherein said liquid crystal panel comprises a plurality of pixels arranged in rows and columns, and wherein the number of rows of pixels per unit height, or pitch, of the liquid crystal panel is a first value; the number of lenslets per unit height, or pitch, of said first lens array is a second value which is less than said first value; and the number of lenslets per unit height, or pitch, of said second lens array is a third value which is greater than said first value.

2. A display apparatus in accordance with claim 1 wherein said third value is a non-integral multiple of said first value and is also a non-integral multiple of said second value.

3. A display apparatus comprising:

a light source;

a liquid crystal panel mounted adjacent to said light source for receiving light from said light source; and

first and second lens arrays, each having a plurality of individual lenslets, disposed between said light source and said liquid crystal panel for providing a predetermined variation with viewing angle of light transmission from said light source through said lens arrays and said liquid crystal panel, wherein at least one of said first and second lens arrays is rotated about an axis perpendicular to said liquid crystal panel in order to provide a slight misalignment between said lenslets and said liquid crystal panel.

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A DIRECTIONAL DIFFUSER FOR A
LIQUID CRYSTAL DISPLAY

BACKGROUND OF THE INVENTION

This invention relates in general to flat panel liquid crystal displays and, more particularly, to a liquid crystal display (LCD) having a directional diffuser to provide a tailored variation of luminance with viewing angle.

There are commercially available liquid crystal displays for use in various applications, including for example aircraft cockpit displays. However, a typical characteristic of the liquid crystal panel used therein is a wide variation of the light transmission of the liquid crystal panel with viewing angle, especially the vertical viewing angle. This results in gray-scale errors and off-state errors with viewing angle. That is to say, the brightness of certain areas of the display when viewed at angles above or below a vertical viewing angle normal to the display surface, may be substantially different than the brightness of those areas when viewed at an angle normal to the display surface. This variation of brightness or luminance with viewing angle is generally undesirable and particularly undesirable in those cases where the information being displayed on the liquid crystal display is critical to an operation such as controlling or navigating an aircraft.

In addition, a typical diffuser used to provide a light source for backlighting a typical liquid crystal display ordinarily provides a constant luminance with viewing angle and therefore provides the same amount of energy for any given viewing angle of the display. In certain applications, such as for example an aircraft cockpit, the typical vertical viewing angle is fixed within a relatively narrow range and it would therefore be desirable to concentrate a higher percentage of the energy from the light source within a particular range of viewing angles.

It would therefore be desirable to provide a directional diffuser for use with a liquid crystal display to provide a tailored variation of luminance with viewing angle while also providing a concentration of the light energy from the light source within a predetermined range of viewing angles.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a directional diffuser element for a liquid crystal display to provide a tailored variation of luminance with viewing angle.

It is a further object of the present invention to provide a liquid crystal display having less variation of intermediate gray-level luminance with viewing angle.

It is still further an object of the present invention to provide a liquid crystal display combining the above features to provide a higher concentration of light energy, and therefore increased luminance, within a particular range of viewing angles thereby providing a more efficient use of light energy available from a light source.

The foregoing and other objects are achieved in the present invention wherein there is provided a liquid crystal display apparatus comprising a light source, a liquid crystal planar array of pixels for creating an image by controlling the amount of light allowed to pass through each of the pixels, and one or more directional diffuser lens arrays disposed between the light source and the liquid crystal array for providing a tailored variation of luminance from the liquid crystal display as a function of vertical viewing angle.

DRAL
P

BRIEF DESCRIPTION OF THE DRAWINGS

The above mentioned and other features and objects of the present invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of alternative embodiments of the invention taken in conjunction with the accompanying drawings wherein:

P

Figure 1 is an exploded view of a typical prior art backlit liquid crystal display;

P

Figure 2 is an exploded view of the liquid crystal display of the present invention, having a directional diffuser lens array;

P

Figure 3 illustrates a typical prior art LCD gray-level response showing the variation of luminance with vertical viewing angle;

P

Figures 4A and 4B show cross sectional side and top views of a typical assembly including the lens array of the present invention;

P

Figure 5 illustrates the variation of luminance with viewing angle for a light source alone and a light source combined with a single lens array;

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Figure 6 illustrates the path of various light rays when striking the lens array at various angles;

Figure 7 is a cross sectional view of a preferred embodiment of the present invention with two lens arrays;

Figure 8 illustrates the variation of luminance with viewing angle for the dual lens array configuration;

Figure 9 illustrates the variation of luminance with viewing angle for a triple lens array configuration;

Figure 10 is a cross sectional view of a configuration utilizing a triangular shaped lens array;

Figure 11 illustrates the variation of luminance with viewing angle for the triangular shaped lens array; and

Figure 12 shows the angular rotation of the lens array with respect to the LCD matrix array to eliminate residual moire effects.

DECE
P

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to Figure 1 there is shown a cross section of a typical prior art liquid crystal display apparatus including backlight array 25 comprising lamp 10, rear reflecting surface 15 and lambertian diffuser 20. The backlight array provides a source of light which impinges on liquid crystal panel 30 comprised of a number of individual liquid crystal elements which are alternately energized in order to form a desired pattern or image for viewing from the front of the liquid crystal display.

While this typical prior art liquid crystal panel may be adequate for certain applications where the normal viewing angle is more or less at an angle normal to the display surface, this display is not optimum for applications wherein the typical viewing angle is other than at an angle normal to the display surface. This prior art display exhibits a relatively wide variation of light transmission with viewing angle, especially the vertical viewing angle. As illustrated in Figure 3, this variation also changes with the level of lumination for various gray-levels or intermediate intensities for a given display.

As can be seen in the curves of Figure 3, the luminance emitted from the lower gray-levels of the LCD system increases significantly with increasing vertical viewing angle. This variation presents an undesirably large luminance increase

with angle when the information being presented is low-level luminance information, such as for avionics applications including weather radar or attitude director indicator presentations. As a pilot viewing the display moves his vertical perspective, or his viewing angle, higher above a normal angle to the display (larger vertical viewing angles), he observes a low luminance field increase significantly in luminance, thereby causing confusion in interpretation of critical display information.

In addition, the lambertian diffuser of the typical prior art display, element 20 of Figure 1, provides for a nearly equal luminance in all angular viewing directions. In most applications a 180° field of view in both horizontal and vertical directions is not required. It would therefore be more energy efficient if a substantial portion of the light energy could be redirected so as to be concentrated in the viewing angles of interest for a particular application.

The apparatus of the present invention includes the backlight array and liquid crystal of the prior art as shown in Figure 1 with the addition of a lens array 40 inserted between the lambertian diffuser 20 of the prior art and liquid crystal display panel 30, as shown in Figure 2. It was found that by inserting a directional diffuser consisting of a cylindrical lens array 40 between the lambertian diffuser and the liquid crystal panel that both of the desired effects could be accomplished. That is, the overall light energy is

concentrated within a desired range of viewing angles and the variation of luminance with viewing angle is tailored to offset that which is obtained through the liquid crystal display alone.

For example, Figure 5 illustrates that with the insertion of lens array 40 as shown in Figures 4A and 4B, the overall luminance has increased approximately 20 percent within a range from -20° to $+20^{\circ}$ viewing angle and the desired decrease in luminance with increased vertical viewing angle is obtained between approximately $+10^{\circ}$ and $+35^{\circ}$ of vertical viewing angle. Curve 110 of Figure 5 illustrates the variation of luminance with viewing angle for the lambertian light source only, in both the horizontal and vertical angles while curves 120 and 130 respectively represent a variation of luminance with vertical and horizontal viewing angles for the backlight including lens array 40.

The effect which results from the insertion of the cylindrical lens array is explained by reference to Figure 6 wherein there are shown light rays from the lambertian (having uniform luminance with angle) source diffuser impinging on the lens array from various angles. An air gap must be present at the interface of the lambertian diffuser and the lens array. The normal 4 percent loss per surface due to fresnel reflections is not incurred, because the surface reflections are returned to the diffuser and reflected again.

Those rays that are normal to the source diffuser but

less than the critical angle within the lens array are passed through the lens array materially unobstructed, except for a small amount of surface reflection. Rays which enter at oblique angles and are greater than the critical angle of the lens array undergo total internal reflection at the inside of the lens surface as illustrated by ray tracing 70. These rays are reflected with no loss due to the total internal reflection effect around the lens periphery. They exit the rear of the lens array and return to the source diffuser where they undergo a secondary diffuse reflection from the source diffuser.

However, because the source diffuser is not totally reflective, some of the returned rays are transmitted through the diffuser and are then reflected from the backlight enclosure surface 15 of Figure 4A. Some fraction of these rays are reflected internally to exit the diffuser again. These reflected rays again have a lambertian distribution at the surface of lambertian diffuser 20. It is apparent from this interaction between the lens array and the backlight that rays which impinge close to the normal tend to be intensified while those rays which impinge at oblique angles undergo total internal reflection and are returned to the diffuser and diminished somewhat from this statistical process.

However, the roll off or variation with vertical viewing angle for this single directional diffuser cylindrical lens array was not sufficient to offset the effects of the

liquid crystal display, and there were significant moire patterns caused by the interference between the lens array and the display panel wherein the lens array contained 142 lenses per inch and the display panel matrix had a spatial frequency resolution of 172 dots or pixels per inch.

For the desired specific implementation it was discovered that the adverse interaction producing moire patterns could be eliminated by including a second lens array with a different number of lenses per inch. The combination of the dual lenses increased the desired reduction in luminance with increased viewing angle, and in addition reduced or eliminated the moire patterns with the selection of an appropriate pitch, or number of lenses per inch, for the two lenses in question.

As illustrated in Figure 7, one of the lens arrays 42 was selected to have a relatively coarse pitch with respect to that of the liquid crystal display and the second lens array 44 was selected to have a relatively fine pitch with respect to that of liquid crystal display. Figure 8 illustrates again the relatively flat response of the lambertian source diffuser alone curve 110, and the increased roll off with vertical viewing angle of curve 125 as well as the corresponding variation of luminance with horizontal viewing angle as illustrated by curve 135 for the dual lens array of Figure 8.

In general it was discovered that the addition of additional lens arrays caused a steeper or more rapid varia-

tion of the change in luminance with vertical viewing angle, which was desirable, but the corresponding change in luminance with variations in horizontal viewing angle also became steeper, which was not desirable for the particular application in question. For the particular application in question the preferred embodiment included two lens arrays in series which provided the best tradeoff of decrease in luminance with variation of vertical viewing angle, while not adversely affecting the variation in luminance with horizontal viewing angle.

In addition, since moire effects result when both of the lens arrays have the same spatial frequency, the rear array 42 should have a coarse resolution or low spatial frequency while the front lens array 44 should have a fine resolution or high spatial frequency. The lens arrays and the panel spatial frequencies should be selected to avoid integral multiples of the other. Thus the fine lens array should be as high a spatial frequency as is practical and should be a non-integral multiple of the panel frequency. According to these guidelines the fine array frequency becomes approximately 2.5 times the display spatial frequency and the coarse array frequency should be approximately the fine array frequency divided by 3.5, 4.5, 5.5 or as required for the most convenient fabrication.

It was also discovered that the maximum increase in luminance was obtained using a triangular lens array having an

included angle of 90° as illustrated in Figure 10. This configuration resulted in a variation of luminance with vertical and horizontal viewing angles which was quite steep as illustrated by curves 160 and 170 of Figure 11. Other lens array shapes may be selected as desired to obtain the required concentration of luminance and variation of luminance with vertical and horizontal viewing angle for a particular application.

Even though the spatial frequencies of the directional diffuser lens array and LCD panel have been selected to be greatly different and non-integer multiples, some visual banding effects or moire pattern effects may still be apparent to the viewer. This is especially true at off-axis viewing conditions. This residual moire can be removed by rotating the lens array 40 with the respect to the LCD array 30, as illustrated in Figure 12. This rotation of the lens array by a few degrees (Typically 2 to 16 degrees) from the horizontal axis causes a small change in the effective spatial frequency difference of the two arrays and thereby eliminates the residual moire.

In addition to the angular redistribution of the light from the directional diffuser, the lens array also provides an additional diffusing effect, especially for any step variations in luminance that are parallel to (or nearly parallel to within a few degrees) the axis of the lens array. This allows the reduction of the thickness or optical density of the

conventional diffuser while still achieving the same system luminance uniformity and masking of undesired spatial artifacts from the light source, but with higher luminance at the output.

While there have been described above the principals of invention in conjunction with several specific embodiments, it is to be clearly understood that these descriptions are made only by way of example and not as a limitation to the scope of the invention.

CM We claim

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CLAIMS

Claim 1. A display apparatus comprising:

a light source;

a substantially planar array mounted adjacent to said light source for receiving light from said light source, said array comprising a plurality of controllable apertures for creating an image by controlling the amount of light from said light source which is allowed to pass through each of said apertures; and

luminance control means disposed between said light source and said planar array for providing a predetermined variation with viewing angle of light transmission from said light source through said luminance control means and said planar array.

Claim 2. A display apparatus in accordance with Claim 1 wherein said planar array comprises a liquid crystal panel having a characteristic variation of light transmission with viewing angle.

Claim 3. A display apparatus in accordance with Claim 2 wherein said luminance control means comprises a first lens array having a plurality of individual lenslets.

sub B' ^a

Claim 4. A display apparatus in accordance with ^{Claim 10} ~~Claim 3~~ wherein each of said lenslets has a semi-cylindrical shape.

^a Claim 5. A display apparatus in accordance with ^{Claim 10} ~~Claim 3~~ wherein each of said lenslets has a triangular cross section.

⁵ Claim 6. A display apparatus in accordance with Claim 3 wherein said luminance control means further comprises a second lens array disposed between said first lens array and said liquid crystal panel.

¹⁰ Claim 7. A display apparatus in accordance with ^{Claim 10} ~~Claim 6~~ wherein said liquid crystal panel comprises a plurality of pixels arranged in rows and columns, and wherein the number of rows of pixels per unit height, or pitch, of the liquid crystal panel is a first value; the number of lenslets per unit height, or pitch, of said first lens array is a second value which is less than said first value; and the number of lenslets per unit height, or pitch, of said second lens array is a third value which is greater than said first value.

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²⁵ Claim 8. A display apparatus in accordance with ^{Claim 10} ~~Claim 7~~ wherein said third value is a non-integral multiple of said first value and is also a non-integral multiple of said second value.

Claim 3

nb ~~2132~~

Claim 9. A display apparatus in accordance with Claim 3 wherein said first lens array is rotated about an axis perpendicular to said liquid crystal panel in order to provide a slight misalignment between said lenlets and said liquid crystal panel.

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ABSTRACT OF THE DISCLOSURE

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A display apparatus including a light source, a liquid crystal panel, and one or more directional diffuser lens arrays disposed therebetween provides a tailored variation of luminance with viewing angle, a uniform variation of luminance with viewing angle within a first predetermined range of viewing angles and a concentration of light energy within a second predetermined range of viewing angles.

EA

✓

DOCKET No. A6213491

Application for United States Citizenship

PATENT

Declaration and Power of Attorney

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled
"A DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY"

The specification of which

(check Y is attached hereto
one) was filed on _____ as
Application Serial No. _____
and was amended on _____.
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No

I hereby claim the benefit under Title 35, United States Code §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
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100		

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: DALE E. JEPSEN (Reg. No. 31,379), Albin Medved (Reg. No. 22,719), Roger W. Jensen (Reg. No. 17,651) and Donald J. Lenkasus (Reg. No. 28,096). Address all telephone calls to 602/436-1336 (MR. JEPSEN) at telephone number _____.

Address all correspondence to DALE E. JEPSEN, Office of General Counsel, Honeywell Inc.,
21,111 N. 19TH AVENUE, DV9L, PHOENIX, AZ 85027

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-00
Full Name of Sole or First Inventor RICHARD ISAIAH MCCARTNEY JR.
Inventor's Signature Richard Isaiah McCartney Jr. Date 7-8, 1992
Residence 5638 E. HELENA DR., SCOTTSDALE, ARIZONA 85254 AZ
Citizenship USA
Post Office Address 5638 E. HELENA DR., SCOTTSDALE, ARIZONA 85254

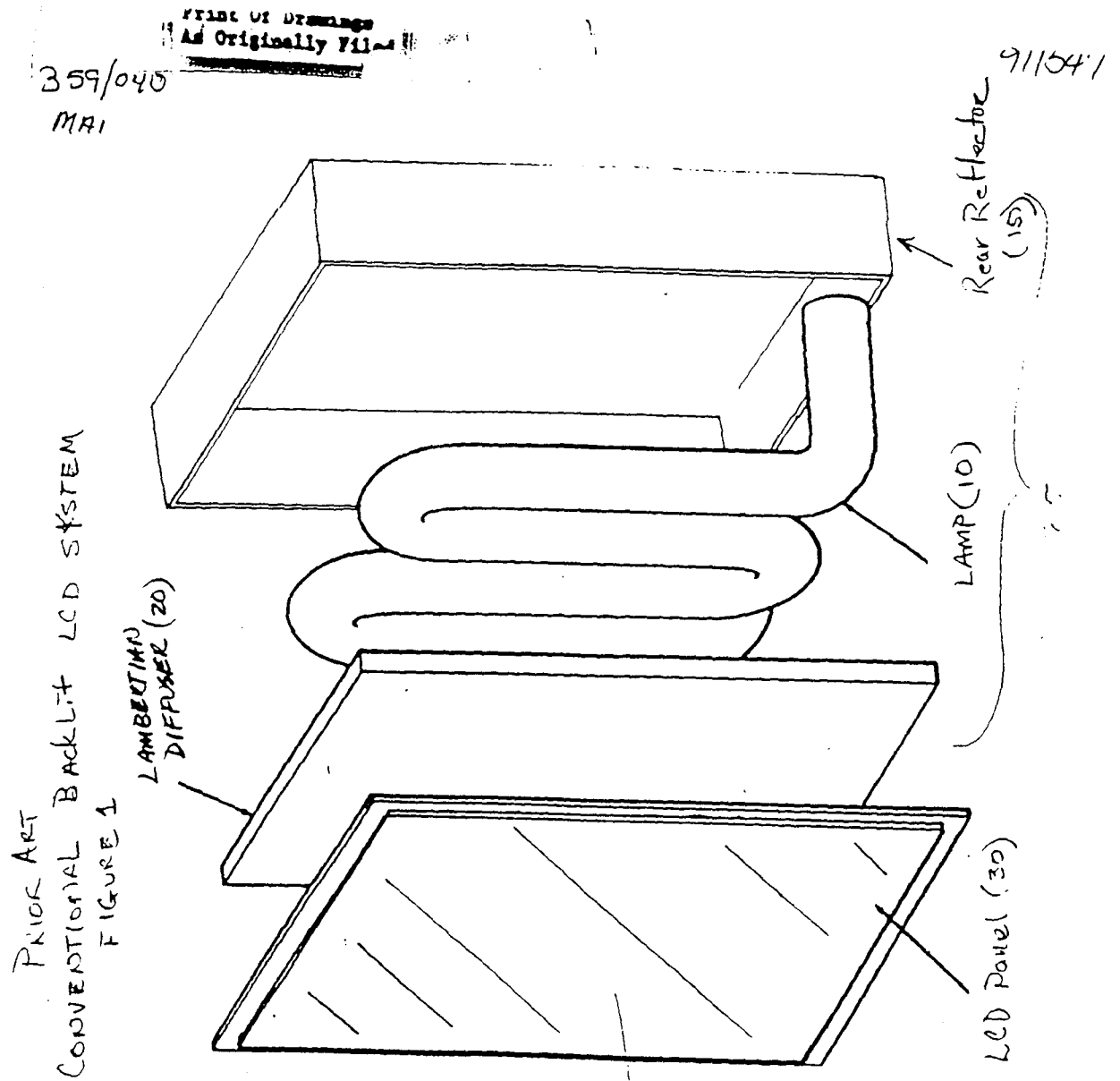
2-00
Full Name of Second Joint Inventor, if Any DANIEL DAVID SYROID
Inventor's Signature Daniel David Syroid Date July 8, 1992
Residence 6627 W. ROBERT E. LEE, GLENDALE, ARIZONA 85308 AZ
Citizenship US
Post Office Address 6627 W. ROBERT E. LEE, GLENDALE, AZ 85308

3-00
Full Name of Third Joint Inventor, if Any KAREN ELISABETH JACHIMOWICZ
Inventor's Signature Karen Elisabeth Jachimowicz Date 7-8, 1992
Residence 16333 W. MAGNOLIA ST., GOODYEAR, ARIZONA 85338 AZ
Citizenship US
Post Office Address 16333 W. MAGNOLIA ST., GOODYEAR, ARIZONA 85338

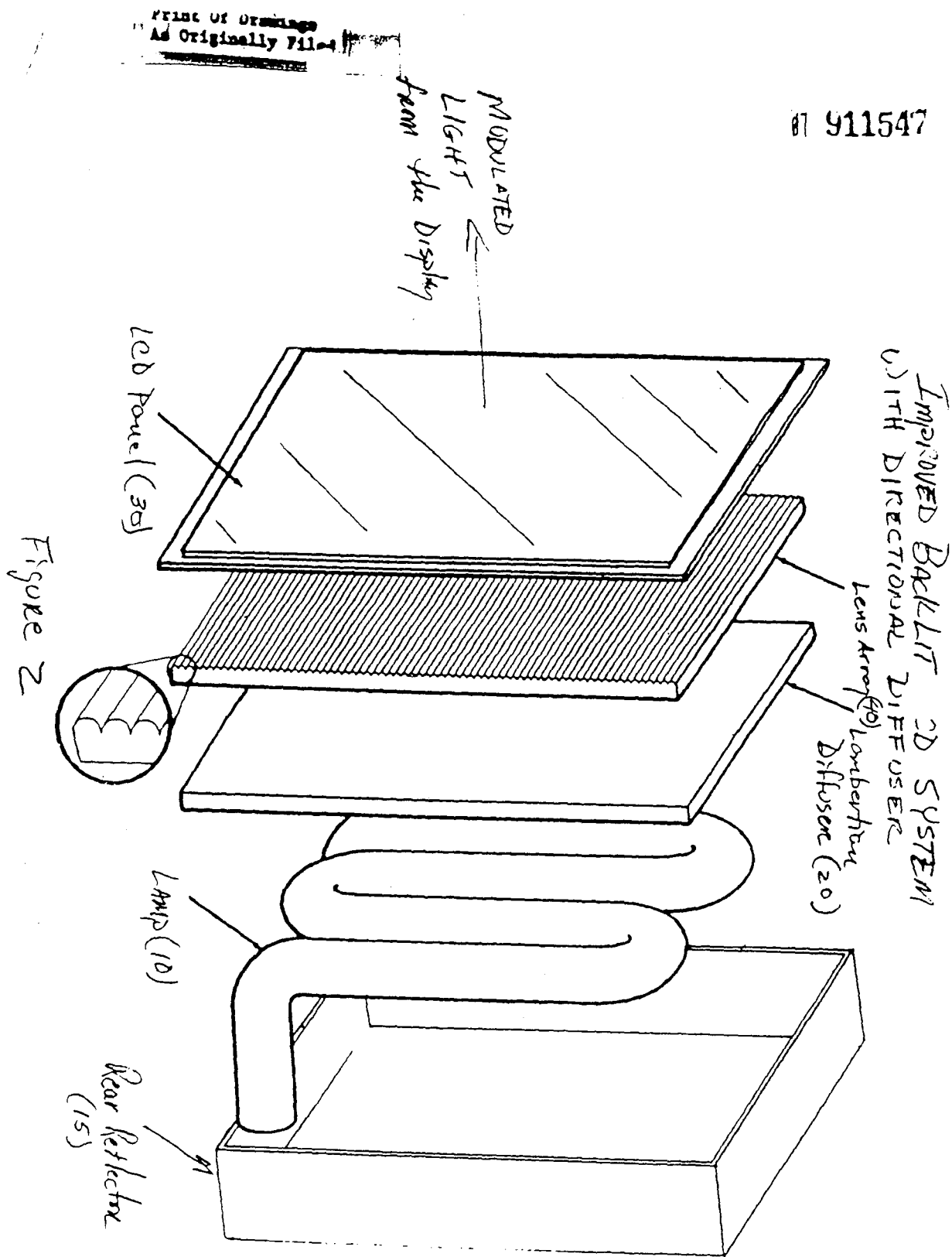
*Title 37, Code of Federal Regulations §1.56(a):

38

A duty of candor and good faith toward the Patent and Trademark Office rests on the inventor, on each attorney or agent who prepares or prosecutes the application and on every other individual who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application. All such individuals have a duty to disclose to the Office information they are aware of which is material to the examination of the application. Such information is material where there is substantial likelihood that a reasonable examiner would consider it important in deciding whether to allow the application to issue as a patent. The duty is commensurate with the degree of involvement in the preparation or prosecution of the application.



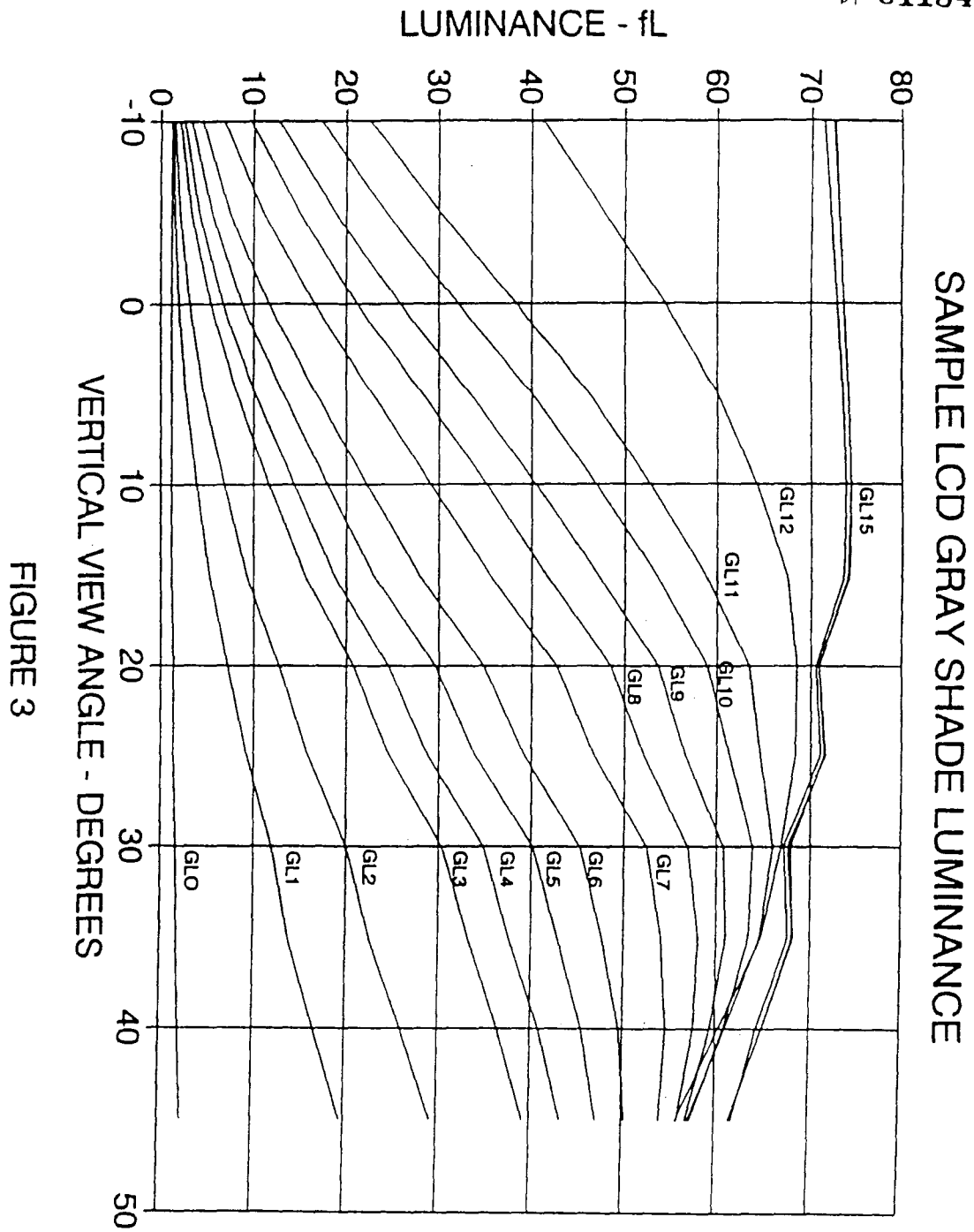
Modulated
Light
from the Display



69
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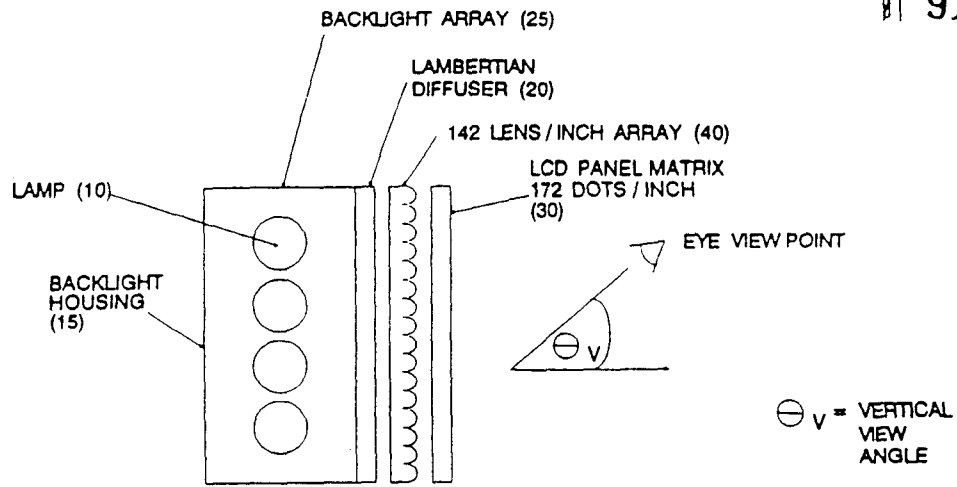
Print Of Drawings
As Originally Filed

911547

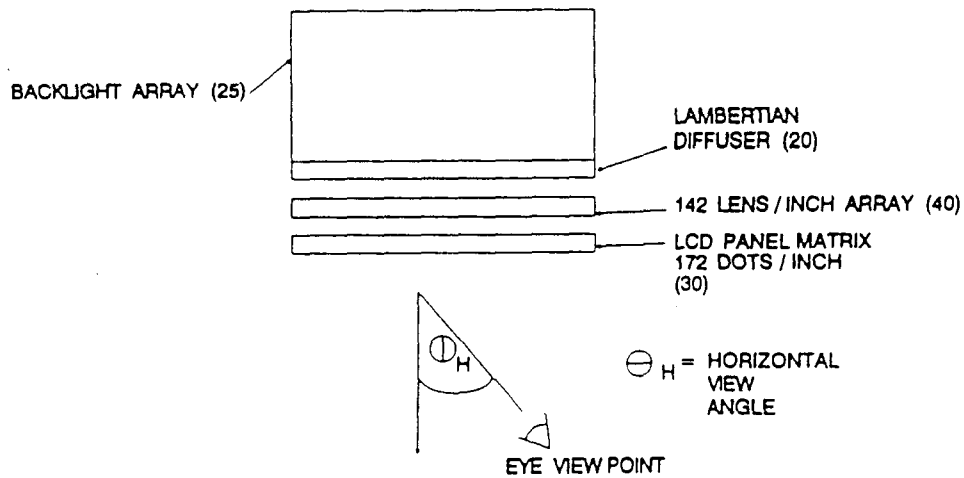


Print Of Drawings
As Originally Filed

87 911547



SINGLE CYLINDRICAL LENS ARRAY
FIGURE 4A



SINGLE CYLINDRICAL LENS ARRAY
FIGURE 4B

Print of Drawings
As Originally Filed

911547

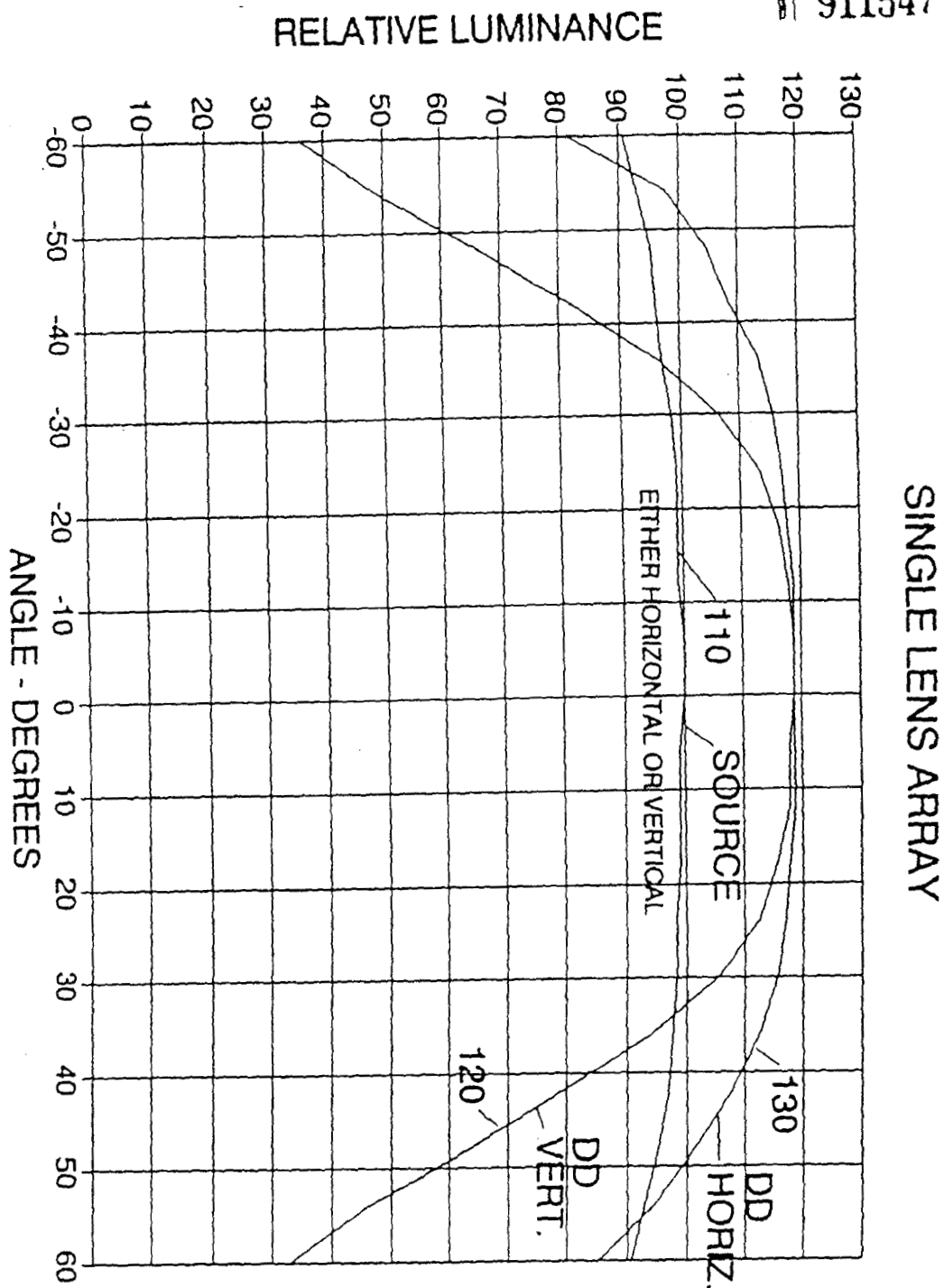


FIGURE 5

Print of Drawings
As Originally Filed

87 911547

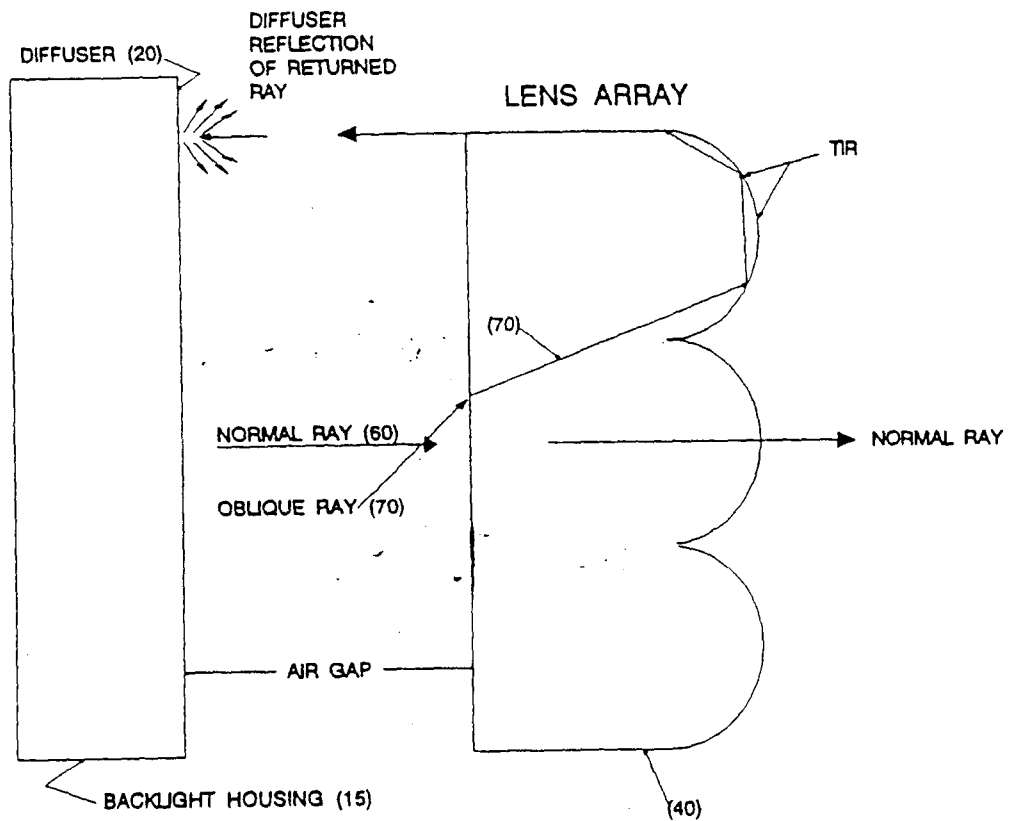


FIGURE 6

Print Of Drawings
As Originally Filed

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PREFERRED EMBODIMENT

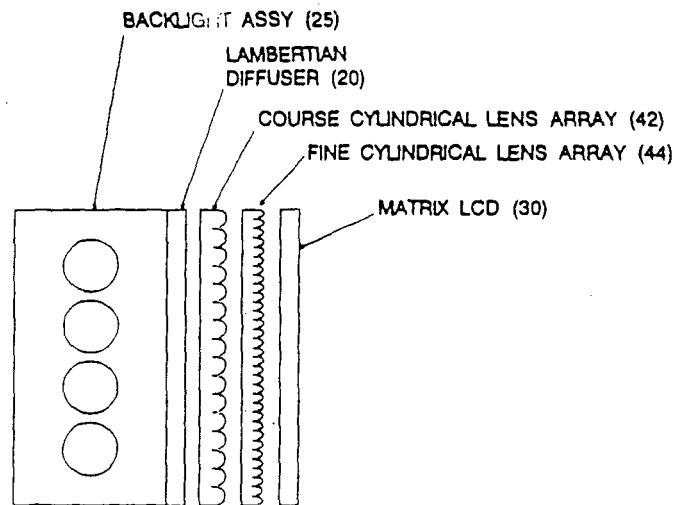


FIGURE 7

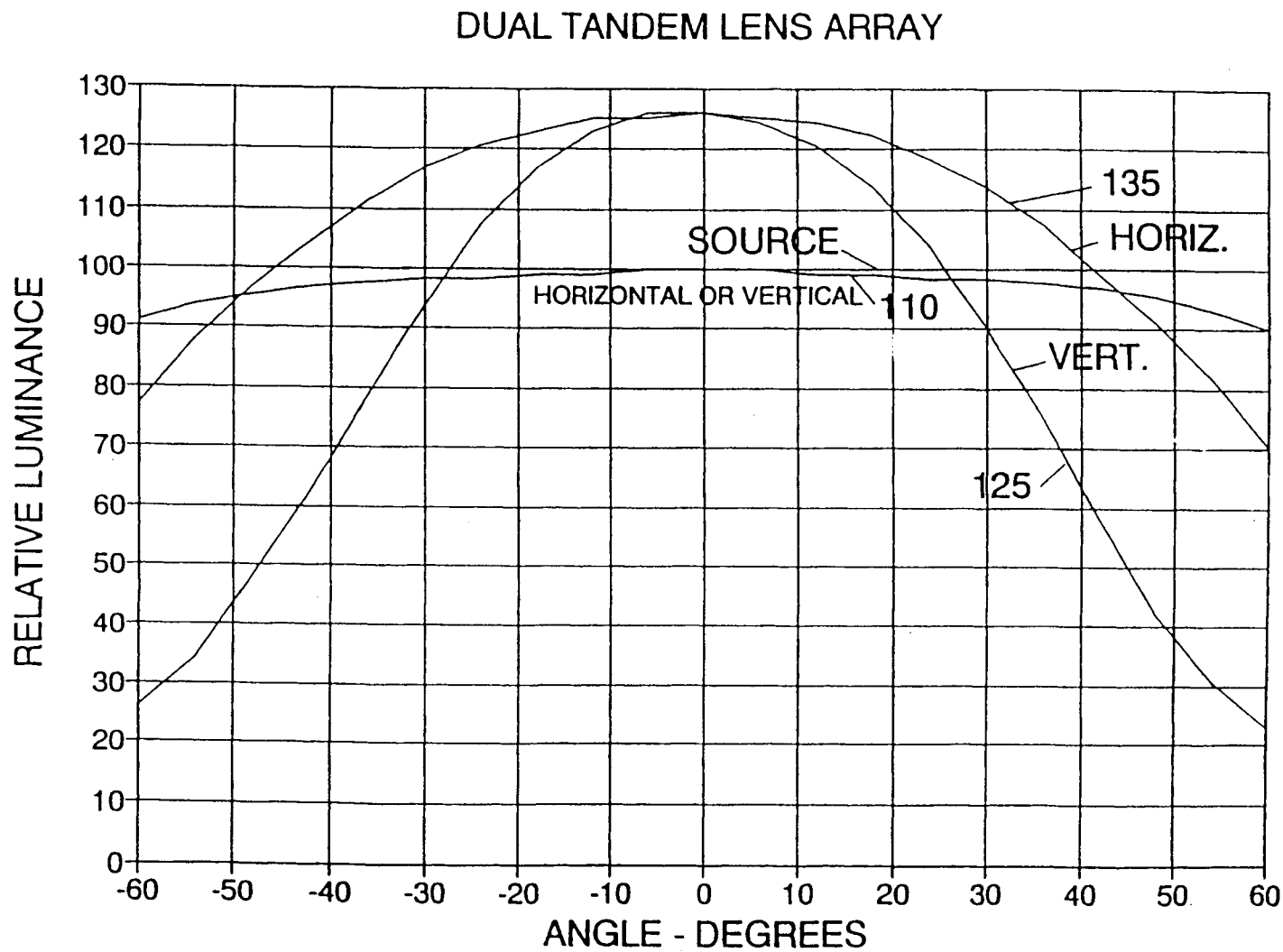


FIGURE 8

Print of Drawings
As Originally Filed

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Print Of Drawings
As Originally Filed

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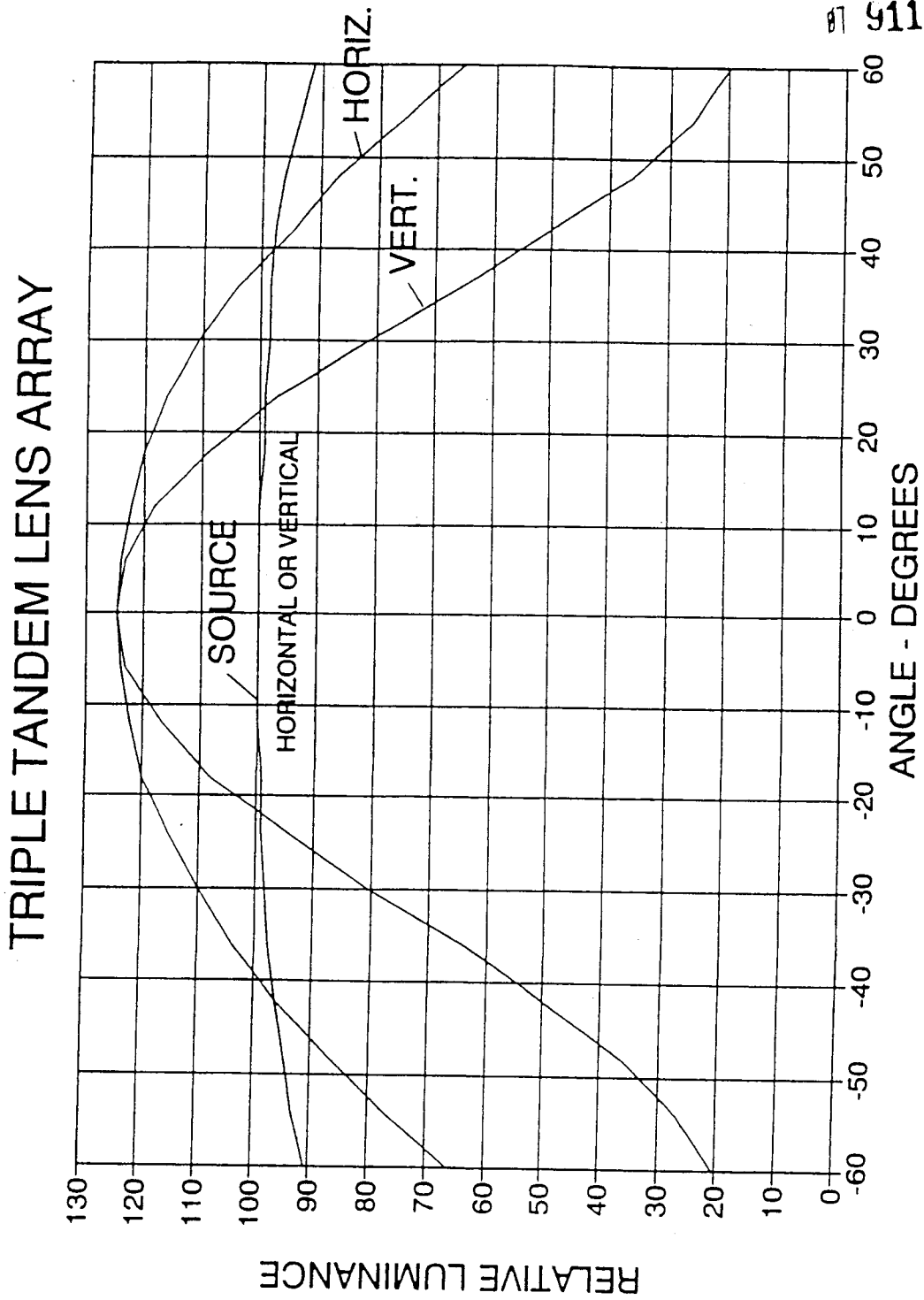
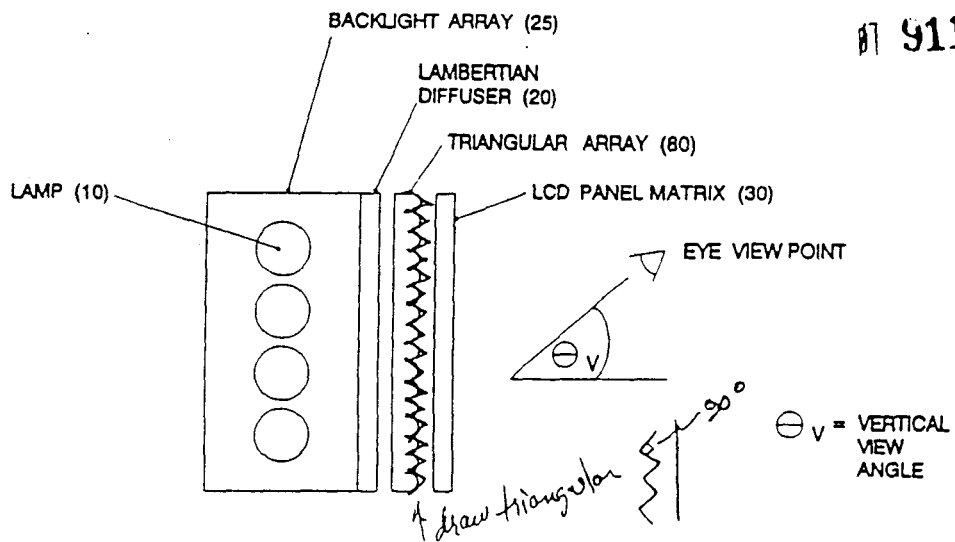


FIGURE 9

Print of Drawings
As Originally Filed

911547

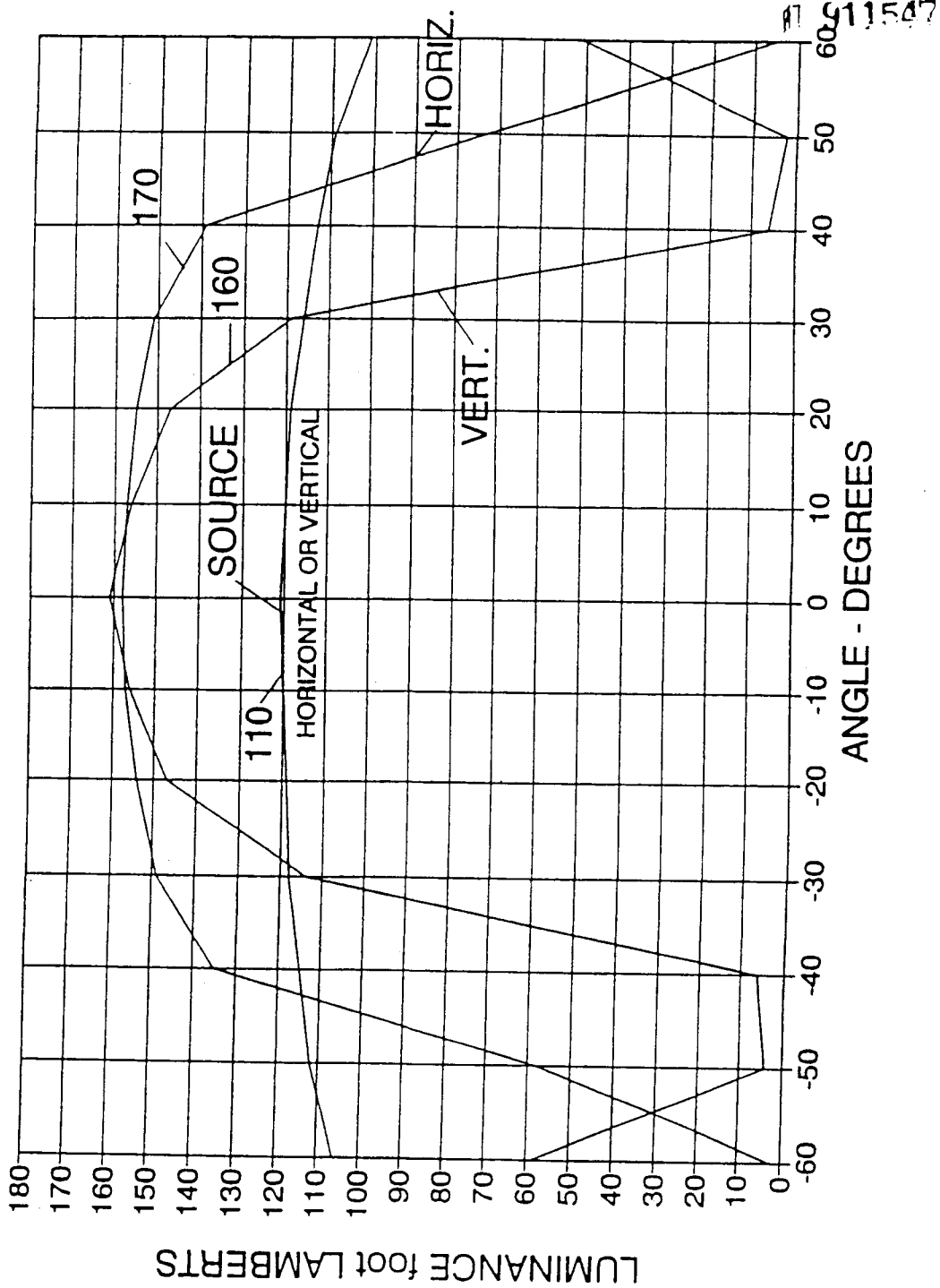


TRIANGULAR LENS ARRAY

FIGURE 10

PRINT OF DRAWINGS
As Originally Filed

FIGURE 11



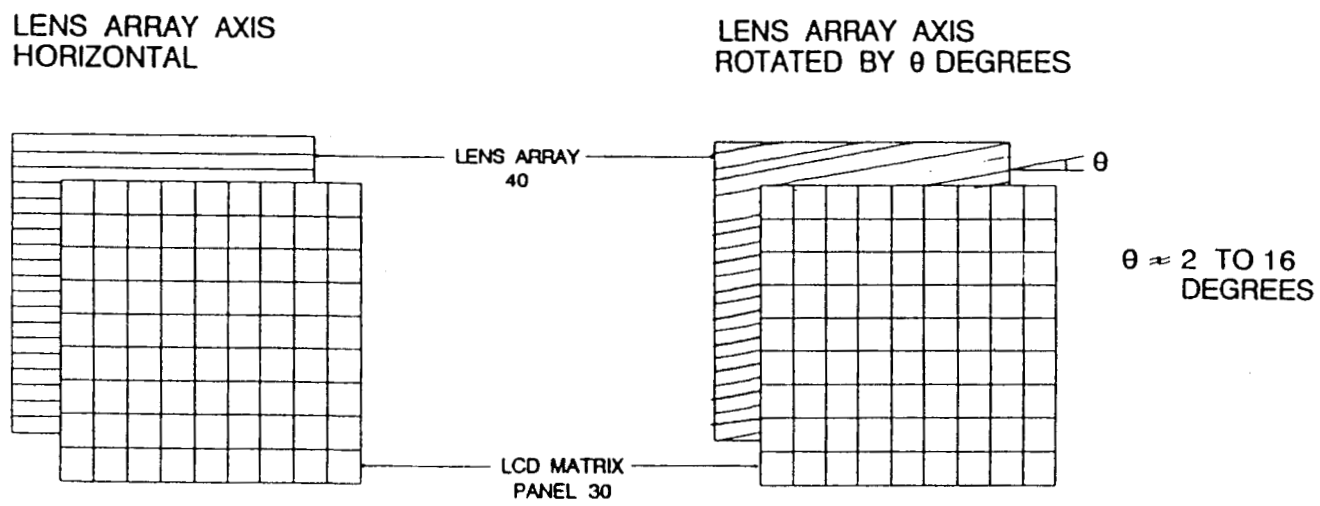


FIGURE 12

87 911547 *CLP*PATENT
#3

PATENT APPLICATION TRANSMITTAL LETTER

TO THE COMMISSIONER OF PATENTS AND TRADEMARKS:

Transmitted herewith for filing is the patent application of RICHARD I. MCCARTNEY JR. ET AL

for "A DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY"

Enclosed are:

☒ 12 sheets of drawing (INFORMAL)

☒ an assignment of the invention to HONEYWELL INC., HONEYWELL PLAZA, MINNEAPOLIS, MN

☐ a certified copy of a _____ application.

☒ associate power of attorney.

Claims as Filed

For	Number Filed	Number Extra	Rate	Fee
Total claims.....	9 -20 =	0	x \$20=	0
Independent claims.....	1 -3 =	0	x \$72=	0
Basic fee (minimum amount required).....				690.00
If filing multiple dependent claims add \$220.				
Total Filing Fee				690.00
<input checked="" type="checkbox"/> For Recording of Assignment				40.00

☒ Please charge Deposit Account 08-2727 in the amount of \$ 730.00
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees or credit any overpayment under 37 CFR 1.16 and 1.17 which may be required during the entire pendency of the application to Deposit Account No 08-2727. A duplicate copy of this sheet is enclosed.

☐ A check in the amount of \$ _____ to cover the filing fee is enclosed.

9 JULY 1992

date

DALE E. JEPSEN
DALE E. JEPSEN

Attorney of Record

51

31,379

Attorney Registration No.

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark OfficeAddress: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
07/911,547	07/09/92	MC CARTNEY	R A6213491

EXAMINER
MAI, HDALE E. JEPSEN
HONEYWELL INC.
21,111 N. 19TH AVENUE, DUBL
PHOENIX, AZ 85027ART UNIT
2504
PAPER NUMBER
3

DATE MAILED: 10/02/92

This is a communication from the examiner in charge of your application.
COMMISSIONER OF PATENTS AND TRADEMARKS☒ This application has been examined ☐ Responsive to communication filed on _____ ☐ This action is made final.A shortened statutory period for response to this action is set to expire 3 month(s), 0 days from the date of this letter.
Failure to respond within the period for response will cause the application to become abandoned. 35 U.S.C. 133

Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:

- | | |
|---|--|
| 1. <input checked="" type="checkbox"/> Notice of References Cited by Examiner, PTO-892. | 2. <input checked="" type="checkbox"/> Notice re Patent Drawing, PTO-948. |
| 3. <input type="checkbox"/> Notice of Art Cited by Applicant, PTO-1449. | 4. <input type="checkbox"/> Notice of Informal Patent Application, Form PTO-152. |
| 5. <input type="checkbox"/> Information on How to Effect Drawing Changes, PTO-1474. | 6. <input type="checkbox"/> _____ |

Part II SUMMARY OF ACTION

1. ☒ Claims 1-9 are pending in the application.
Of the above, claims _____ are withdrawn from consideration.
2. ☐ Claims _____ have been cancelled.
3. ☐ Claims _____ are allowed.
4. ☒ Claims 1-9 are rejected.
5. ☐ Claims _____ are objected to.
6. ☐ Claims _____ are subject to restriction or election requirement.
7. ☒ This application has been filed with informal drawings under 37 C.F.R. 1.85 which are acceptable for examination purposes.
8. ☐ Formal drawings are required in response to this Office action.
9. ☐ The corrected or substitute drawings have been received on _____. Under 37 C.F.R. 1.84 these drawings are ☐ acceptable. ☐ not acceptable (see explanation or Notice re Patent Drawing, PTO-948).
10. ☐ The proposed additional or substitute sheet(s) of drawings, filed on _____ has (have) been ☐ approved by the examiner. ☐ disapproved by the examiner (see explanation).
11. ☐ The proposed drawing correction, filed on _____, has been ☐ approved. ☐ disapproved (see explanation).
12. ☐ Acknowledgment is made of the claim for priority under U.S.C. 119. The certified copy has ☐ been received ☐ not been received
☐ been filed in parent application, serial no. _____; filed on _____
13. ☐ Since this application appears to be in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11; 453 O.G. 213.
14. ☐ Other

52

EXAMINER'S ACTION

Serial No. 911,547

-2-

Art Unit 2504

The following is a quotation of the appropriate paragraphs of 35 U.S.C. § 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-5 are rejected under 35 U.S.C. § 102(a or b) as being clearly anticipated by Abileah et al or IBM (article).

The limitations of claims 1-5 are drawn in Abileah et al's Figs. 3-4 or IBM's Fig. 1. Abileah et al teach ^{a device comprising} a light source 100, a substantially planar array 10 and luminance control means 102.

The following is a quotation of 35 U.S.C. § 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Subject matter developed by another person, which qualifies as prior art only under subsection (f) or (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

Serial No. 911,547

-3-

Art Unit 2504

Claims 1-3 and 6-9 are rejected under 35 U.S.C. § 103 as being unpatentable over Abileah et al or IBM (article) in view of Hamada.

The basic structure of claims 1-3 and 6-9 are shown in Abileah et al's Figs. 3-4 or IBM's Fig. 1, except for a second lens array disposed between the first lens array and the liquid crystal panel. Hamada teaches in Figs. 5A-B and 7 a liquid crystal display panel having microlens arrays provided at a side of the liquid crystal cell for improving the brightness of the display panel. Therefore, it would have been obvious at the time the invention was made to one skilled in this art to utilize a liquid crystal display apparatus comprising a light source, a liquid crystal cell and luminance control means having a first lens array and a second lens array interposed between the light source and the liquid crystal cell like Abileah et al or IBM's in view of Hamada. It would have been obvious because of the second lens array in the Hamada patent for improving the brightness of the display; One skilled in this art would have been motivated to combine the Hamada's liquid crystal panel in to the Abileah et al or IBM's display apparatus for improving the brightness display. Therefore, claims 1-3 and 6-9 are unpatentable under 35 USC 103 over Abileah et al. or IBM in view of Hamada.

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

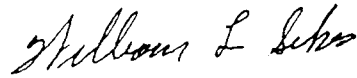
Serial No. 911,547

-4-

Art Unit 2504

Any inquiry concerning this communication should be directed
to Examiner Huy K. Mai at telephone number (703) 308-4874.

HM/
Mai/ks
September 30, 1992


WILLIAM L. SIKES
SUPERVISORY PATENT EXAMINER
GROUP ART UNIT 251

TO SEPARATE, HOLD TOP AND BOTTOM EDGES, SNAP-APART AND DISCARD CARBON

FORM PTO-892 (REV. 3-78)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		SERIAL NO. 07/911,547	GROUP/UNIT 2509	ATTACHMENT TO PAPER NUMBER 3			
NOTICE OF REFERENCES CITED				APPLICANT(S) Mc Cartney, Jr. et al					
U.S. PATENT DOCUMENTS									
		DOCUMENT NO.	DATE	NAME	CLASS	SUB-CLASS	FILING DATE IF APPROPRIATE		
A		5128783	7/7/92	Nielsen et al	359	40	1-31-90		
B		5101279	3/31/92	Huromatsu et al	359	40			
C		5052783	10/1/91	Huromatsu	359	41			
D		4416515	11/22/83	Furomatsu et al	359	69			
E									
F									
G									
H									
I									
J									
K									
FOREIGN PATENT DOCUMENTS									
		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUB-CLASS	PERTINENT SHTS. DWG.	PP. SPEC.
L		0214822	8-90	Japan	ishihara	359	69		
M		0068400	10-77	Japan	Tanaka	359	69		
N									
O									
P									
Q									
OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)									
R		IBM corp, "polarized backlight for liquid crystal display" IBM Technical Disclosure bulletin, vol 33 No. 1B, June 1990 pp. 143-144.							
S									
T									
U									
EXAMINER Moi			DATE 4-28-92		56				
* A copy of this reference is not being furnished with this office action. (See Manual of Patent Examining Procedure, section 707.05 (a).)									

PTO FORM 948
(Rev. 5-91)U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

ATTACHMENT TO PAPER NUMBER

3

GROUP

APPLICATION NUMBER

911547

NOTICE OF DRAFTSMAN'S PATENT DRAWING REVIEW

The PTO Draftsmen review all originally filed drawings regardless of whether they were designated as informal or formal.

The drawings filed 7/9/92A. ☐ are approved.B. ☒ Are objected to under 37 CFR 1.84 on reason(s) checked below. The examiner will require submission of next corrected drawings at the appropriate time. Corrected drawings must be submitted according to the instructions listed on the back of this Notice.

1. Paper and Ink. 37 CFR 1.84(a)

- ☐ Poor Quality Paper. Must Be White.
Transparent Paper Not Allowed.
Sheet(s) _____

2. Size of Sheet and Margins. 37 CFR 1.84(b)

Acceptable Paper Sizes and Margins

Paper Size

Margin	8 1/2 by 14 inches	8 1/2 by 13 inches	11 by 17 inches
Top	2 inches	1 inch	2.5 cm
Left	1/4 inch	1/4 inch	2.5 cm
Right	1/4 inch	1/4 inch	1.5 cm
Bottom	1/4 inch	1/4 inch	1.5 cm

☒ Proper Size Paper Required. All papers undersized.
Sheets Must be Same Size.
Sheet(s) 1-12

☐ Proper Margins Required.

- Sheet(s) _____
- ☐ Top ☐ Right
☐ Left ☐ Bottom

3. Character of Lines. 37 CFR 1.84(c)

☒ Lines Pale, Rough and Blurred, or Jagged. Fig(s) 1, 2, 6, 10, 12

☐ Solid Black Shading Not Allowed.

Fig(s) _____

4. ☐ Photographs Not Approved.☐ Comments:

5. Hatching and Shading. 37 CFR 1.84(d)

- ☐ Shade Lines are Required.
Fig(s) _____
- ☐ Criss-Cross Hatching Not Allowed.
Fig(s) _____
- ☐ Double Line Hatching Not Allowed.
Fig(s) _____
- ☐ Parts in Section Must be Hatched Properly. Fig(s) _____

6. Reference Characters. 37 CFR 1.84(f)

☒ Reference Characters Poor or Rough and Blurred. Fig(s) 1, 2, 10

☐ Minimum 1/8 inch (3.2 mm.) in height is required. Fig(s) _____

☒ Figure Legends Poor or Placed Incorrectly. Fig(s) 1-12

7. Views. 37 CFR 1.84(i) & (j)

- ☒ Figures Must be Numbered Separately.
Fig. 2
- ☐ Figures Must Not be Connected.
Fig(s) _____

8. Identification of Drawings. 37 CFR 1.84(l)

☒ Extraneous Matter or Copy Machine Marks Not Allowed. Fig(s) 1-10, 12

9. ☐ Changes Not Completed from Prior PTO-948 dated _____

57

Telephone inquiries concerning this review should be directed to the Chief Draftsman at telephone number (703) 557-6404.

I. Roop
Reviewing Draftsman

7/28/92
Date



"PATENT"

Applicant: R. McCartney et al } Art Unit: 2504
Serial No.: 07/911,547 } Examiner: H. Mai
Filed: 9 July 1992 } Docket No.: A6213491
For: "A DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY"

AMENDMENT

Honorable Commissioner of
Patents and Trademarks
Washington, D.C. 20231

RECEIVED

FEB 23 1993

GROUP 2500

Dear Sir:

In response to the Office Action mailed on 2 October 1992, please amend the above-identified application as follows:

IN THE CLAIMS

58

Kindly delete claims 1, 2 and 3.

Kindly amend claims 4, 5, 7 and 9 as follows:

In claims 4 and 5, at line 1, delete "Claim 3", and substitute therefor - - Claim 10 - -.

In claim 7, at line 1, delete "Claim 6", and substitute therefor - - Claim 10 - -.

Claim 9. (Amended) A display apparatus in accordance with Claim [3] 10 wherein at least one of said first and second lens arrays is rotated about an axis perpendicular to said liquid crystal panel in order to provide a slight misalignment between said lenslets and said liquid crystal panel.

Docket No. A6213491

1

2 February 1993

Kindly add new claim 10 as follows:

Claim 10. A display apparatus comprising:

a light source;

a liquid crystal panel mounted adjacent to said light source for receiving light from said light source; and

first and second lens arrays, each having a plurality of individual lenslets, disposed between said light source and said liquid crystal panel for providing a predetermined variation with viewing angle of light transmission from said light source through said lens arrays and said liquid crystal panel.

REMARKS

The applicants wish to thank the Examiner for his citation to the noted references and his accompanying remarks. While the cited references are certainly pertinent to the claimed invention, applicants respectfully disagree with the interpretation of the cited references by the Examiner and his conclusions drawn therefrom.

The Examiner has rejected claims 1-5 under 35 USC 102 (a or b) as being clearly anticipated by Abileah et al or the cited IBM article. While not necessarily providing the same function, the structure of these references does appear to be similar to that of applicants' invention. In order to further prosecution of the application, claims 1-3 have been deleted

and claims 4 and 5 amended to depend from new claim 10.

In addition, the Examiner has rejected claims 1-3 and 6-9 under 35 USC 103 as being unpatentable over Abileah et al or the IBM article in view of Hamada. Applicants have added new claim 10 which essentially includes the limitations of claims 1-3 and 6, resulting in a new claim for an apparatus having two lens arrays.

The Examiner contends that it would have been obvious, in view of Hamada, to add a second lens array to the structure of Abileah or IBM. In order to support a combination of references under 35 USC 103 there must be some suggestion for the combination. As the Hamada reference is concerned with a projection apparatus, there would be no suggestion to use the dual lens arrays of Hamada in the direct view apparatus of Abileah or IBM. Particularly since the dual lens array of Hamada is used to overcome a problem specifically associated with projection displays.


The two lens arrays of Hamada are used in a projection device to reduce the dimming at the outer edges. As such the dual lens arrays would not be suggested to the direct view display of Abileah or IBM.

In addition, at no point in any of the references is there any discussion of eliminating moire effects with appropriate selection of the relative pitch of the two lens arrays as specifically described and claimed by the applicants. Also, there is no discussion of rotating one of the

lens arrays with respect to the liquid crystal panel as specifically claimed in applicants' claim 9.

Based on the foregoing, applicants contend that claims 4, 5, 7, 9 and 10, as amended, are in condition for allowance and respectfully request same at the earliest opportunity.

Respectfully submitted,



Dale E. Jepsen
Attorney for Applicants
Reg. No. 32, 379

602/436-1336

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE



In re application of: R. MCCARTNEY ET AL

Serial No.: 07/911,547

Group No.: 2504 ✓

Filed: 9 JULY 1992

Examiner: H. MAI

For: "A DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY"

Commissioner of Patents and Trademarks
Washington, D.C. 20231

AMENDMENT TRANSMITTAL

RECEIVED

FEB 23 1993

GROUP 2500

1. Transmitted herewith is an amendment for this application.

STATUS

2. Applicant is
- ☐ a small entity — verified statement:
 - ☐ attached.
 - ☐ already filed.
 - ☒ other than a small entity.

"EXPRESS MAIL" Date of Deposit 2 FEBRUARY 1993
Mailing Label No. 1B379304420US

I hereby certify that this paper or fee is being deposited with
the United States Postal Service "Express Mail Post Office to
Addressee" service under 37 CFR 1.10 on the date indicated
above and is addressed to the Commissioner of Patents and
Trademarks, Washington, D.C. 20231

DALE E. JEPSEN

(Typed or printed name of person mailing paper or fee)

[Signature]
(Signature of person mailing paper or fee)

(Amendment Transmittal [9-19]—page 2 of 4)

EXTENSION OF TERM

NOTE: "Extension of Time in Patent Cases (Supplement Amendments) — If a timely and complete response has been filed after a Non-Final Office Action, an extension of time is not required to permit filing and/or entry of an additional amendment after expiration of the shortened statutory period.

If a timely response has been filed after a Final Office Action, an extension of time is required to permit filing and/or entry of a Notice of Appeal or filing and/or entry of an additional amendment after expiration of the shortened statutory period unless the timely-filed response placed the application in condition for allowance. Of course, if a Notice of Appeal has been filed within the shortened statutory period, the period has ceased to run." Notice of December 10, 1985 (1061 O.G. 34-35).

NOTE: See 37 CFR 1.645 for extensions of time in interference proceedings and 37 CFR 1.550(c) for extensions of time in reexamination proceedings.

3. The proceedings herein are for a patent application and the provisions of 37 CFR 1.136 apply

(complete (a) or (b) as applicable)

(a) ☒ Applicant petitions for an extension of time under 37 CFR 1.136 (fees: 37 CFR 1.17(a)-(d) for the total number of months checked below:

Extension (months)	Fee for other than small entity	Fee for small entity
<input checked="" type="checkbox"/> one month	\$ 110.00	\$ 55.00
<input type="checkbox"/> two months	\$ 360.00	\$180.00
<input type="checkbox"/> three months	\$ 840.00	\$420.00
<input type="checkbox"/> four months	\$1,320.00	\$660.00
Fee \$ <u>110.00</u>		

If an additional extension of time is required please consider this a petition therefor.

(check and complete the next item, if applicable)

☐ An extension for _____ months has already been secured and the fee paid therefor of \$_____ is deducted from the total fee due for the total months of extension now requested.

Extension fee due with this request \$_____

OR

(b) ☐ Applicant believes that no extension of term is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition for extension of time.

(Amendment Transmittal [9-19]—page 3 of 4)

FEE FOR CLAIMS

4. The fee for claims (37 CFR 1.16(b)-(d)) has been calculated as shown below:

(Col. 1)		(Col. 2)		(Col. 3)		SMALL ENTITY		OTHER THAN A SMALL ENTITY	
CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NO PREVIOUSLY PAID FOR		PRESENT EXTRA		ADDIT. FEE		ADDIT. FEE	
TOTAL	5	MINUS	9	=	0	x10=	\$	x20=	\$
INDEP.	1	MINUS	1	=	0	x36=	\$	x72=	\$
<input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEP. CLAIM						+110=	\$	+220=	\$
						TOTAL ADDIT. FEE	\$	OR TOTAL ADDIT. FEE	\$

* If the entry in Col. 1 is less than entry in Col. 2, write "0" in Col. 3.

** If the "Highest No. Previously Paid for" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest No. Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest No. Previously Paid For" (Total or Indep.) is the highest number found in the appropriate box in Col. 1 of a prior amendment or the number of claims originally filed.

WARNING: "After final rejection or action (§ 1.113) amendments may be made cancelling claims or complying with any requirement of form which has been made." 37 CFR § 1.116(a) (emphasis added)

(complete (c) or (d) as applicable)

(c) ☒ No additional fee for claims is required.**OR**(d) ☐ Total additional fee for claims required \$_____.**FEE PAYMENT**5. ☐ Attached is a check in the sum of \$_____.☒ Charge Account No. 08-2727 the sum of \$ 110.00.

A duplicate of this transmittal is attached.

FEE DEFICIENCY

NOTE: If there is a fee deficiency and there is no authorization to charge an account, additional fees are necessary to cover the additional time consumed in making up the original deficiency. If the maximum, six-month period has expired before the deficiency is noted and corrected, the application is held abandoned. In those instances where authorization to charge is included, processing delays are encountered in returning the papers to the PTO Finance Branch in order to apply these charges prior to action on the cases. Authorization to charge the deposit account for any fee deficiency should be checked. See the Notice of April 7, 1986, (1065 O.G. 31-33).

6. ☒ If any additional extension and/or fee is required, charge Account No. 08-2727.

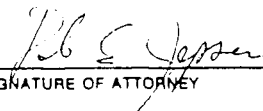
(Amendment Transmittal [9-19]—page 4 of 4)

AND/OR

☐ If any additional fee for claims is required, charge Account No. _____

Reg. No.: 31,379

Tel. No.: (602) 436-1336



SIGNATURE OF ATTORNEY

DALE F. JEPSEN

Type or print name of attorney
HONEYWELL INC

21111 N. 19TH AVE.

P.O. Address
PHOENIX, ARIZONA 85027

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark OfficeAddress: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
07/911,547	07/09/92	MC CARTNEY	R A6213491

B5H2

MATH EXAMINER

DALE E. JEPSEN
HONEYWELL INC.
21,111 N. 19TH AVENUE, DVP
PHOENIX, AZ 85027ART UNIT 2504
PAPER NUMBER 5

DATE MAILED: 05/16/93

This is a communication from the examiner in charge of your application.
COMMISSIONER OF PATENTS AND TRADEMARKS
☐ This application has been examined ☒ Responsive to communication filed on 2/2/93 ☒ This action is made final.

A shortened statutory period for response to this action is set to expire 3 month(s), 0 days from the date of this letter.
Failure to respond within the period for response will cause the application to become abandoned. 35 U.S.C. 133

Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:

1. ☒ Notice of References Cited by Examiner, PTO-892.
2. ☐ Notice re Patent Drawing, PTO-948.
3. ☐ Notice of Art Cited by Applicant, PTO-1449.
4. ☐ Notice of Informal Patent Application, Form PTO-152.
5. ☐ Information on How to Effect Drawing Changes, PTO-1474.
6. ☐ _____

Part II SUMMARY OF ACTION

1. ☒ Claims 1-10 are pending in the application.
Of the above, claims _____ are withdrawn from consideration.
2. ☒ Claims 1-3 have been cancelled.
3. ☐ Claims _____ are allowed.
4. ☒ Claims 4-6 & 10 are rejected.
5. ☒ Claims 7-9 are objected to.
6. ☐ Claims _____ are subject to restriction or election requirement.
7. ☒ This application has been filed with informal drawings under 37 C.F.R. 1.85 which are acceptable for examination purposes.
8. ☐ Formal drawings are required in response to this Office action.
9. ☐ The corrected or substitute drawings have been received on _____. Under 37 C.F.R. 1.84 these drawings are ☐ acceptable. ☐ not acceptable (see explanation or Notice re Patent Drawing, PTO-948).
10. ☐ The proposed additional or substitute sheet(s) of drawings, filed on _____, has (have) been ☐ approved by the examiner. ☐ disapproved by the examiner (see explanation).
11. ☐ The proposed drawing correction, filed on _____, has been ☐ approved. ☐ disapproved (see explanation).
12. ☐ Acknowledgment is made of the claim for priority under U.S.C. 119. The certified copy has ☐ been received ☐ not been received
☐ been filed in parent application, serial no. _____; filed on _____.
13. ☐ Since this application appears to be in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11; 453 O.G. 213.
14. ☐ Other

66

EXAMINER'S ACTION

Serial No. 911,547

-2-

Art Unit 2504

Applicant's arguments with respect to claims 4-10 have been considered but are deemed to be moot in view of the new grounds of rejection.

Claim 6 is rejected under 35 U.S.C. § 112, fourth paragraph, as being of improper dependent form for failing to further limit the subject matter of a previous claim.

Claim 6 depends from claim 3 which has been canceled. Therefore, claim 6 is not treated on the merits.

The following is a quotation of the appropriate paragraphs of 35 U.S.C. § 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --
(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

Claims 5 and 10 are rejected under 35 U.S.C. § 102(e) as being clearly anticipated by Abileah et al ('041) or Yoshida et al.

The recited limitations of claims 5 and 10 are shown in Abileah et al's Figs. 6, 8, column 13, line 18 through column 14, line 44 or Yoshida et al's Figs. 3, 5.

The following is a quotation of 35 U.S.C. § 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject

Serial No. 911,547

-3-

Art Unit 2504

matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Subject matter developed by another person, which qualifies as prior art only under subsection (f) or (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

Claim 4 is rejected under 35 U.S.C. § 103 as being unpatentable over Abileah et al ('041) in view of Abileah et al ('783).

The '041 patent discloses in Figs. 6, 8 a display apparatus having first and second lens arrays with lenslets having a triangular cross section. The '041 patent lacks a teaching the lenslets having a semi-cylindrical shape.

The '783 patent teaches in Fig. 3 a lens array having lenslets disposed between a liquid crystal panel and a light source wherein the lenslets have semi-cylindrical shape for improving the brightness of the display device. Therefore, it would have been obvious at the time the invention was made to a person skilled in this art to modify the '041 patent by substituting the lens arrays with lenslets having semi-cylindrical shape for the lens arrays with triangular-cross-section lenslets for improving the brightness of the display as taught by the '783 patent.

Serial No. 911,547

-4-

Art Unit 2504

Claims 7 and 9 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim 8 is objected to as being dependent upon an objected claim which has allowable subject matter.


Applicant's amendment necessitated the new grounds of rejection. Accordingly, THIS ACTION IS MADE FINAL. See M.P.E.P. § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 C.F.R. § 1.136(a).

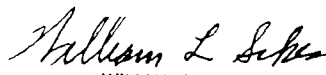
A SHORTENED STATUTORY PERIOD FOR RESPONSE TO THIS FINAL ACTION IS SET TO EXPIRE THREE MONTHS FROM THE DATE OF THIS ACTION. IN THE EVENT A FIRST RESPONSE IS FILED WITHIN TWO MONTHS OF THE MAILING DATE OF THIS FINAL ACTION AND THE ADVISORY ACTION IS NOT MAILED UNTIL AFTER THE END OF THE THREE-MONTH SHORTENED STATUTORY PERIOD, THEN THE SHORTENED STATUTORY PERIOD WILL EXPIRE ON THE DATE THE ADVISORY ACTION IS MAILED, AND ANY EXTENSION FEE PURSUANT TO 37 C.F.R. § 1.136(a) WILL BE CALCULATED FROM THE MAILING DATE OF THE ADVISORY ACTION. IN NO EVENT WILL THE STATUTORY PERIOD FOR RESPONSE EXPIRE LATER THAN SIX MONTHS FROM THE DATE OF THIS FINAL ACTION.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Huy K. Mai whose telephone number is (703) 308-4874.

Any inquiry of a general nature or relating to the status of this application should be directed to the Group receptionist whose telephone number is (703) 308-0956.

69


Mai/ks
April 26, 1993


WILLIAM L. SIKES
SUPERVISORY PATENT EXAMINER
GROUP 2500

TO SEPARATE, HOLD TOP AND BOTTOM EDGES, SNAP-APART AND DISCARD CARBON

FORM PTO-892 (REV. 3-78)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		SERIAL NO. 07/911 547	GROUP/ART UNIT 2504	ATTACHMENT TO PAPER NUMBER 5		
NOTICE OF REFERENCES CITED				APPLICANT(S) Mc Carthey Jr. et al.				
U.S. PATENT DOCUMENTS								
•		DOCUMENT NO.	DATE	NAME	CLASS	SUB- CLASS	FILING DATE IF APPROPRIATE	
	A	5161041	11/3/92	Abileah et al	354	40	4/24/90	
	B							
	C							
	D							
	E							
	F							
	G							
	H							
	I							
	J							
	K							
FOREIGN PATENT DOCUMENTS								
•		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUB- CLASS	PERTINENT SHTS. DWG. PP. SPEC.
	L							
	M							
	N							
	O							
	P							
	Q							
OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)								
	R							
	S							
	T							
	U							
EXAMINER Mai				DATE 2/23/93		70		
* A copy of this reference is not being furnished with this office action. (See Manual of Patent Examining Procedure, section 707.05 (a).)								



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: RICHARD I. MCCARTNEY, ET AL
Serial No.: 07 / 911,547 Group No.: 2504
Filed: 09 JULY 1992 Examiner: H. MAI
For: "A DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY"

Commissioner of Patents and Trademarks
Washington, D.C. 20231

PATENT DOCKET NO. 2504

2504

#6

7/8/93
A.S.

AMENDMENT TRANSMITTAL

1. Transmitted herewith is an amendment for this application.

STATUS

2. Applicant is
☐ a small entity — verified statement:
☐ attached.
☐ already filed.
☒ other than a small entity.

CERTIFICATE OF MAILING (37 CFR 1.8(a))

I hereby certify that this paper (along with any referred to as being attached or enclosed) is being deposited with the United State Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to the: Commissioner of Patents and Trademarks, Washington, D.C. 20231.

JOANNA JOHNSON

(Type or print name of person mailing paper)

Date: 02 JULY 1993

Joanna Johnson
(Signature of person mailing paper)

0514126 07/07/93 07911547

08-2727 140 115

110.00CH

EXTENSION OF TERM

NOTE: "Extension of Time in Patent Cases (Supplement Amendments) — If a timely and complete response has been filed after a Non-Final Office Action, an extension of time is not required to permit filing and/or entry of an additional amendment after expiration of the shortened statutory period.

If a timely response has been filed after a Final Office Action, an extension of time is required to permit filing and/or entry of a Notice of Appeal or filing and/or entry of an additional amendment after expiration of the shortened statutory period unless the timely-filed response placed the application in condition for allowance. Of course, if a Notice of Appeal has been filed within the shortened statutory period, the period has ceased to run." Notice of December 10, 1985 (1081 O.G. 34-35).

NOTE: See 37 CFR 1.645 for extensions of time in interference proceedings and 37 CFR 1.550(c) for extensions of time in reexamination proceedings.

3. The proceedings herein are for a patent application and the provisions of 37 CFR 1.136 apply

(complete (a) or (b) as applicable)

(a) ☒ Applicant petitions for an extension of time under 37 CFR 1.136 (fees: 37 CFR 1.17(a)-(d) for the total number of months checked below:

Extension (months)	Fee for other than small entity	Fee for small entity
<input checked="" type="checkbox"/> one month	\$ 110.00	\$ 55.00
<input type="checkbox"/> two months	\$ 360.00	\$180.00
<input type="checkbox"/> three months	\$ 840.00	\$420.00
<input type="checkbox"/> four months	\$1,320.00	\$660.00

Fee \$ 110.00

If an additional extension of time is required please consider this a petition therefor.

(check and complete the next item, if applicable)

☐ An extension for _____ months has already been secured and the fee paid therefor of \$_____ is deducted from the total fee due for the total months of extension now requested.

Extension fee due with this request \$_____

OR

(b) ☐ Applicant believes that no extension of term is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition for extension of time.

FEE FOR CLAIMS

4. The fee for claims (37 CFR 1.16(b)-(d)) has been calculated as shown below:

(Col. 1)		(Col. 2)		(Col. 3)		SMALL ENTITY		OTHER THAN A SMALL ENTITY	
CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NO PREVIOUSLY PAID FOR		PRESENT EXTRA		ADDIT. RATE FEE		OR RATE ADDIT. FEE	
TOTAL	3	MINUS	20	=	x11=	\$ 0		x22=	\$ 0
INDEP.	2	MINUS	3	=	x37=	\$ 0		x74=	\$ 0
<input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEP. CLAIM						+115=	\$	+230=	\$
						TOTAL ADDIT. FEE	\$	OR TOTAL ADDIT. FEE	\$ 0

If the entry in Col. 1 is less than entry in Col. 2, write "0" in Col. 3.
 If the "Highest No. Previously Paid for" IN THIS SPACE is less than 20, enter "20".
 If the "Highest No. Previously Paid For" IN THIS SPACE is less than 3, enter "3".
 The "Highest No. Previously Paid For" (Total or Indep.) is the highest number found in the appropriate box in Col. 1 of a prior amendment or the number of claims originally filed.

WARNING: "After final rejection or action (§ 1.113) amendments may be made cancelling claims or complying with any requirement of form which has been made." 37 CFR § 1.116(a) (emphasis added).

(complete (c) or (d) as applicable)

(c) ☒ No additional fee for claims is required.

OR

(d) ☐ Total additional fee for claims required \$ _____

FEE PAYMENT

5. ☐ Attached is a check in the sum of \$ _____.
- ☒ Charge Account No. 08-2727 the sum of \$ 110.00.
- A duplicate of this transmittal is attached.

FEE DEFICIENCY

NOTE: If there is a fee deficiency and there is no authorization to charge an account, additional fees are necessary to cover the additional time consumed in making up the original deficiency. If the maximum, six-month period has expired before the deficiency is noted and corrected, the application is held abandoned. In those instances where authorization to charge is included, processing delays are encountered in returning the papers to the PTO Finance Branch in order to apply these charges prior to action on the cases. Authorization to charge the deposit account for any fee deficiency should be checked. See the Notice of April 7, 1986, (1065 O.G. 31-33).

6. ☒ If any additional extension and/or fee is required, charge Account No. 08-2727.


(Amendment Transmittal [9-19]—page 3 of 4)

AND/OR

☐ If any additional fee for claims is required, charge Account No. _____

Reg. No.: 31,379

Tel. No.: (602) 436-1336



SIGNATURE OF ATTORNEY

DALE E. JEPSEN

Type or print name of attorney

PATENT LAW OFFICE
HONEYWELL INC.
P.O. BOX 21,111
P.O. Address PHOENIX, AZ 85008



PATENT

IN UNITED STATES
PATENT AND TRADEMARKS OFFICE

Applicant: Richard I. McCartney, et al) Art Unit: 2504
Serial No.: 007/911,547) Examiner: H. Mai
Filed: 09 July 1992) Doc. No.: A6213491

For: "A DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY"

AMENDMENT AFTER FINAL REJECTION

Commissioner of U.S.
Patent and Trademark Office
Washington, D.C. 20231

JUL 06 1993

Dear Sir:

In response to the Office Action mailed on 06 May 1993,
please amend the above-identified application as follows:

IN THE CLAIMS

Kindly delete Claims 4, 5, 6 and 10.

Kindly amend Claims 7 and 9 as follows:

Claim 7 (Twice Amended) A display apparatus comprising:

a light source;

a liquid crystal panel mounted adjacent to said light
source for receiving light from said light source; and

75

Docket No. A6213491

1

01 July 1993

Cont'd
B1

first and second lens arrays, each having a plurality of individual lenslets, disposed between said light source and said liquid crystal panel for providing a predetermined variation with viewing angle of light transmission from said light source through said lens arrays and said liquid crystal panel. [A display apparatus in accordance with Claim 10] wherein said liquid crystal panel comprises a plurality of pixels arranged in rows and columns, and wherein the number of rows of pixels per unit height, or pitch, of the liquid crystal panel is a first value; the number of lenslets per unit height, or pitch, of said first lens array is a second value which is less than said first value; and the number of lenslets per unit height, or pitch, of said second lens array is a third value which is greater than said first value.

3
Claim ~~8~~ (Twice Amended) A display apparatus comprising:
a light source;
a liquid crystal panel mounted adjacent to said light source for receiving light from said light source; and
first and second lens arrays, each having a plurality of individual lenslets, disposed between said light source and said liquid crystal panel for providing a predetermined variation with viewing angle of light transmission from said light source through said lens arrays and said liquid crystal panel. [A display apparatus in accordance with Claim 10]

B2
B3

anted
B2

wherein at least one of said first and second lens arrays is rotated about an axis perpendicular to said liquid crystal panel in order to provide a slight misalignment between said lenslets and said liquid crystal panel.

REMARKS

The Examiner has finally rejected Claims 4-6 and 10. Applicants have deleted Claims 4-6 and 10.

The Examiner has objected to Claims 7 and 9, indicating that they would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claims 7 and 9 have been amended as suggested by the Examiner.

The Examiner has objected to Claim 8 as being dependent on an objected claim. Claim 7 has been amended to overcome the noted objection and claim 8, which depends therefrom, should now be allowable.

Applicants having amended Claims 7 and 9 to overcome the Examiner's objections, Claim 8 now depending from allowable Claim 7, and all remaining claims having been canceled, hereby request a Notice of Allowance for Claims 7, 8 and 9, as amended, at the earliest opportunity.

"EXPRESS MAIL" Date of Deposit 7-2-93
 Mailing Label No. LB379304794
 I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231
JOHANNA JOHANSON
 (Typed or printed name of person mailing paper or fee)
JOHANNA JOHANSON
 (Signature of person mailing paper or fee)

Respectfully Submitted,

Dale E. Jeppsen
 Dale E. Jeppsen
 Reg. No. 34,379
 Attorney for Applicants
 602/436-1336

78



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.
07/911,547	07/09/92	MC CARTNEY	R A6213491

DALE E. JEPSEN
HONEYWELL INC.
21,111 N. 19TH AVENUE, B09L
PHOENIX, AZ 85027

BS042/0719

MAI, H	EXAMINER
ART UNIT	PAPER NUMBER
2504	8

DATE MAILED:

07/19/93

EXAMINER INTERVIEW SUMMARY RECORD

All participants (applicant, applicant's representative, PTO personnel):

(1) MARY GOLDSTEIN (3) _____
(2) DALE JEPSEN (4) _____

Date of interview 7-16-93

Type: ☒ Telephonic ☐ Personal (copy is given to ☐ applicant ☐ applicant's representative).

Exhibit shown or demonstration conducted: ☐ Yes ☐ No. If yes, brief description: _____

Agreement ☐ was reached with respect to some or all of the claims in question. ☐ was not reached.

Claims discussed: _____

Identification of prior art discussed: _____

Description of the general nature of what was agreed to if an agreement was reached, or any other comments: _____

Informed the attorney that the amendment after final
has been received.

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(A fuller description, if necessary, and a copy of the amendments, if available, which the examiner agreed would render the claims allowable must be attached. Also, where no copy of the amendments which would render the claims allowable is available, a summary thereof must be attached.)

Unless the paragraphs below have been checked to indicate to the contrary, A FORMAL WRITTEN RESPONSE TO THE LAST OFFICE ACTION IS NOT WAIVED AND MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW (e.g., items 1-7 on the reverse side of this form). If a response to the last Office action has already been filed, then applicant is given one month from this interview date to provide a statement of the substance of the interview.

☐ It is not necessary for applicant to provide a separate record of the substance of the interview.

☐ Since the examiner's interview summary above (including any attachments) reflects a complete response to each of the objections, rejections and requirements that may be present in the last Office action, and since the claims are now allowable, this completed form is considered to fulfill the response requirements of the last Office action.



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.
---------------	-------------	-----------------------	---------------------

07/911,547 07/09/92 MC CARTNEY

B5M2/0719

DALE E. JEPSEN
HONEYWELL INC.
21,111 N. 19TH AVENUE, DV9L
PHOENIX, AZ 85027

R A6213491	
EXAMINER	
MAI, H	
ART UNIT	PAPER NUMBER
2504	H
DATE MAILED:	
07/19/93	

NOTICE OF ALLOWABILITY

PART I.

- ☒ This communication is responsive to THE AMENDMENT FILED ON JULY 2, 1993
- ☒ All the claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice Of Allowance And Issue Fee Due or other appropriate communication will be sent in due course.
- ☒ The allowed claims are 7-9, CLAIMS 1-6 & 10 HAVE BEEN CANCELLED.
- ☐ The drawings filed on _____ are acceptable.
- ☐ Acknowledgment is made of the claim for priority under 35 U.S.C. 119. The certified copy has ☐ been received. ☐ not been received. ☐ been filed in parent application Serial No. _____, filed on _____.
- ☐ Note the attached Examiner's Amendment.
- ☐ Note the attached Examiner Interview Summary Record, PTOL-413.
- ☐ Note the attached Examiner's Statement of Reasons for Allowance.
- ☐ Note the attached NOTICE OF REFERENCES CITED, PTO-892.
- ☐ Note the attached INFORMATION DISCLOSURE CITATION, PTO-1449.

PART II.

A SHORTENED STATUTORY PERIOD FOR RESPONSE to comply with the requirements noted below is set to EXPIRE THREE MONTHS FROM THE "DATE MAILED" indicated on this form. Failure to timely comply will result in the ABANDONMENT of this application. Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

- ☐ Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL APPLICATION, PTO-152, which discloses that the oath or declaration is deficient. A SUBSTITUTE OATH OR DECLARATION IS REQUIRED.
- ☒ APPLICANT MUST MAKE THE DRAWING CHANGES INDICATED BELOW IN THE MANNER SET FORTH ON THE REVERSE SIDE OF THIS PAPER.
 - ☒ Drawing Informalities are indicated on the NOTICE RE PATENT DRAWINGS, PTO-948, attached hereto or to Paper No. 3. CORRECTION IS REQUIRED.
 - ☐ The proposed drawing correction filed on _____ has been approved by the examiner. CORRECTION IS REQUIRED.
 - ☐ Approved drawing corrections are described by the examiner in the attached EXAMINER'S AMENDMENT. CORRECTION IS REQUIRED.
 - ☒ Formal drawings are now REQUIRED.

Any response to this letter should include in the upper right hand corner, the following information from the NOTICE OF ALLOWANCE AND ISSUE FEE DUE: ISSUE BATCH NUMBER, DATE OF THE NOTICE OF ALLOWANCE, AND SERIAL NUMBER.

Attachments:

☐ Examiner's Amendment
☐ Examiner Interview Summary Record, PTOL-413
☐ Reasons for Allowance
☐ Notice of References Cited, PTO-892
☐ Information Disclosure Citation, PTO-1449

☐ Notice of Informal Application, PTO-152
☐ Notice re Patent Drawings, PTO-948
☐ Listing of Bonded Draftsmen
☐ Other

80

WILLIAM L. SIKES
 SUPERVISORY PATENT EXAMINER
 GROUP 2500


**UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office**

 Address: Box ISSUE FEE
 COMMISSIONER OF PATENTS AND TRADEMARKS
 Washington, D.C. 20231

B5N2/0719

 DALE E. JEPSEN
 HONEYWELL INC.
 21,111 N. 19TH AVENUE, DV9L
 PHOENIX, AZ 85027

**NOTICE OF ALLOWANCE
AND ISSUE FEE DUE**

- ☐ Note attached communication from the Examiner
☐ This notice is issued in view of applicant's communication filed

SERIES CODE/SERIAL NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT	DATE MAILED
07/911,547	07/09/92	003	MAI, H	2504 07/19/93
First Named Applicant: MC CARTNEY, RICHARD I. JR.				
TITLE OF INVENTION: DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY				

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
06213491	359-040,000	092	UTILITY	NO	\$1170.00	10/12/93

THE FEE DUE IS THE AMOUNT IN EFFECT AT THIS TIME. IF THE AMOUNT OF THE ISSUE FEE INCREASES PRIOR TO PAYMENT, APPLICANT WILL BE NOTIFIED OF THE BALANCE OF ISSUE FEE DUE.

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT.

PROSECUTION ON THE MERITS IS CLOSED.

THE ISSUE FEE MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED.

HOW TO RESPOND TO THIS NOTICE:

- I. Review the SMALL ENTITY Status shown above.
 If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

- A. If the status is changed, pay twice the amount of the FEE DUE shown above and notify the patent and Trademark Office of the change in status, or

If the SMALL ENTITY is shown as NO:

- A. Pay FEE DUE shown above, or
 B. File verified statement of Small Entity Status before, or with, pay of 1/2 the FEE DUE shown above.

81

- II. Part B of this notice should be completed and returned to the Patent and Trademark Office (PTO) with your ISSUE FEE. Even if the ISSUE FEE has already been paid by charge to deposit account, Part B should be completed and returned. If you are charging the ISSUE FEE to your deposit account, Part C of this notice should also be completed and returned.
- III. All communications regarding this application must give series code (or filing date) and serial number. Please direct all communications prior to issuance to Box ISSUE FEE unless advised to contrary.

IMPORTANT REMINDER: Patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

DOCKET NO. A6213491

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE



In re application of: RICHARD I. MCCARTNEY

Serial No.: 07 / 911,547

Group No.: 2504

Filing Date: 07/09/92

Examiner: H. MAI

"DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY"

Commissioner of Patents and Trademarks
Washington, D.C. 20231

TRANSMITTAL OF FORMAL DRAWINGS

In response to the NOTICE OF INFORMAL DRAWINGS mailed on 07/19/93
(date)

attached please find:

(a) the formal drawing(s) for this application

Number of Sheets 11 SHEETS

NOTE: "Identifying indicia (such as the application number, group art unit, title of the invention, attorney's docket number, inventor's name, number of sheets, etc.) not to exceed 2 3/4 inches (7.0 cm) in width may be placed in a centered location between the side edge within three-fourths inch (19.1 mm.) of the top edge. Either this marking technique on the front of the drawing or the placement, although not preferred, of this information and the title of the invention on the back of the drawings is acceptable." 37 CFR § 1.84(f).

Each sheet of drawing indicates the serial number and Group Art Unit on ☐ the front center ☒ the reverse side of the drawing.

(b) a copy of the NOTICE OF INFORMAL DRAWINGS

DALE E. JEPSEN
SIGNATURE OF ATTORNEY

Reg. No. 31,379

DALE E. JEPSEN

Type or print name of attorney

Tel. No. (602) 436-1336

PATENT LAW OFFICE
HONEYWELL INC.

P.O. Address

P.O. BOX 27,111
PHOENIX, AZ 85036

CERTIFICATE OF MAILING (37 CFR 1.8(a))

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231.

JOANNA JOHNSON

(Type or print name of person mailing paper)

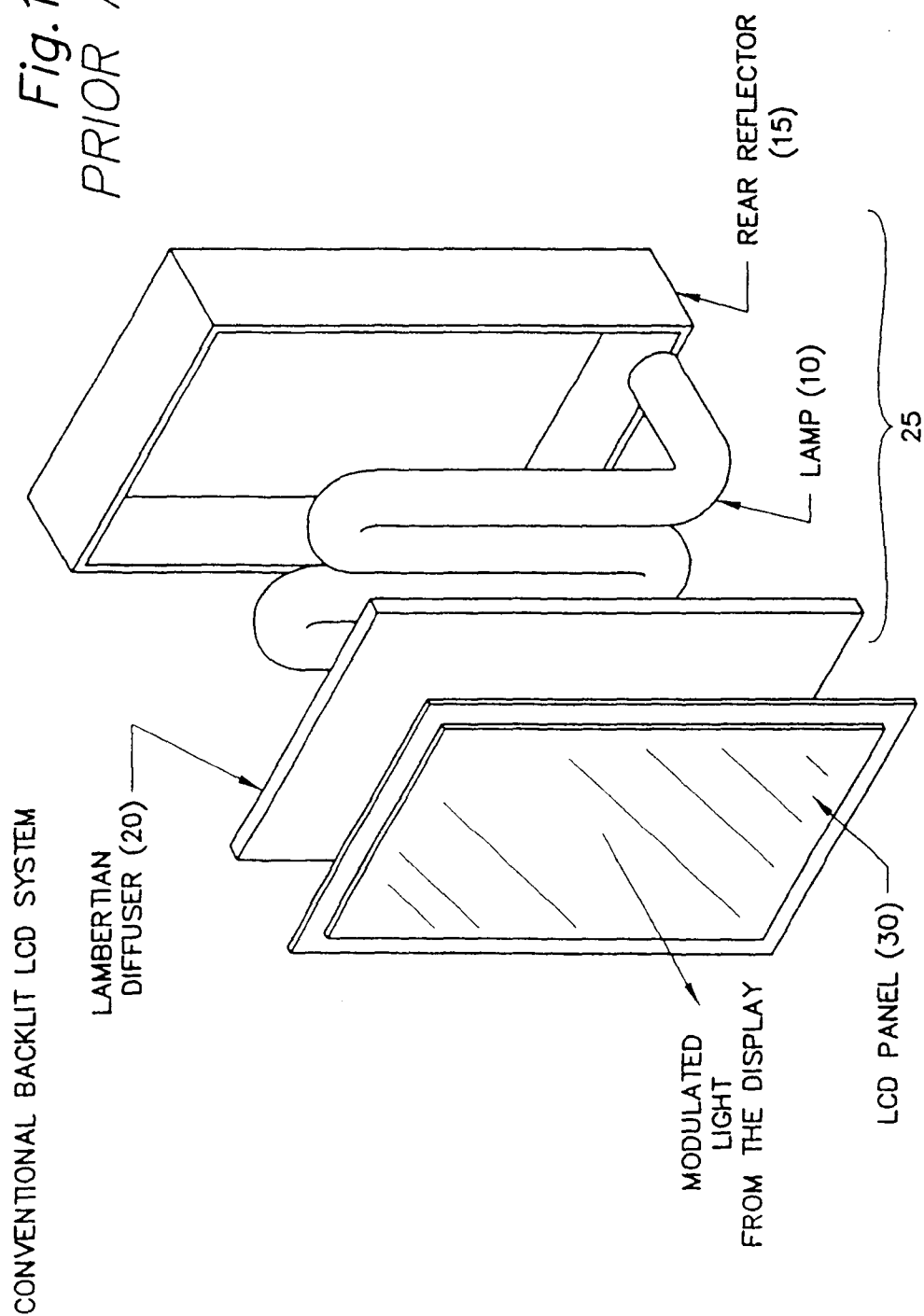
Date 08/27/93

Joanna Johnson
(Signature of person mailing paper)

(Transmittal of Formal Drawings In Response to Notice of Informal Drawings [9-16.1])

HONEYWELL INC.
A6213491 US DEJ
PAGE 1/11

Fig. 1
PRIOR ART



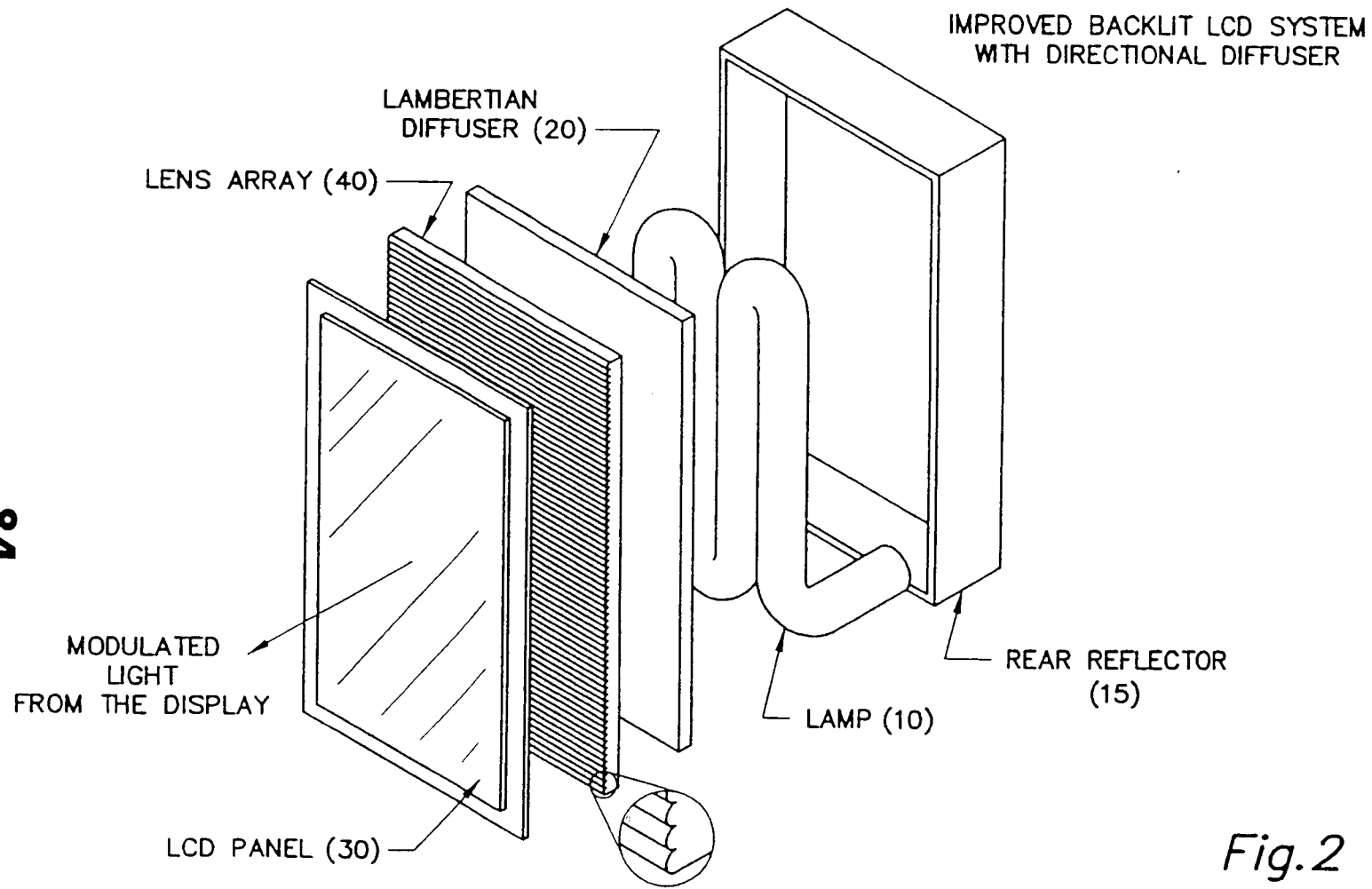


Fig.2

HONEYWELL INC.
A6213491 US DEJ
PAGE 3/11

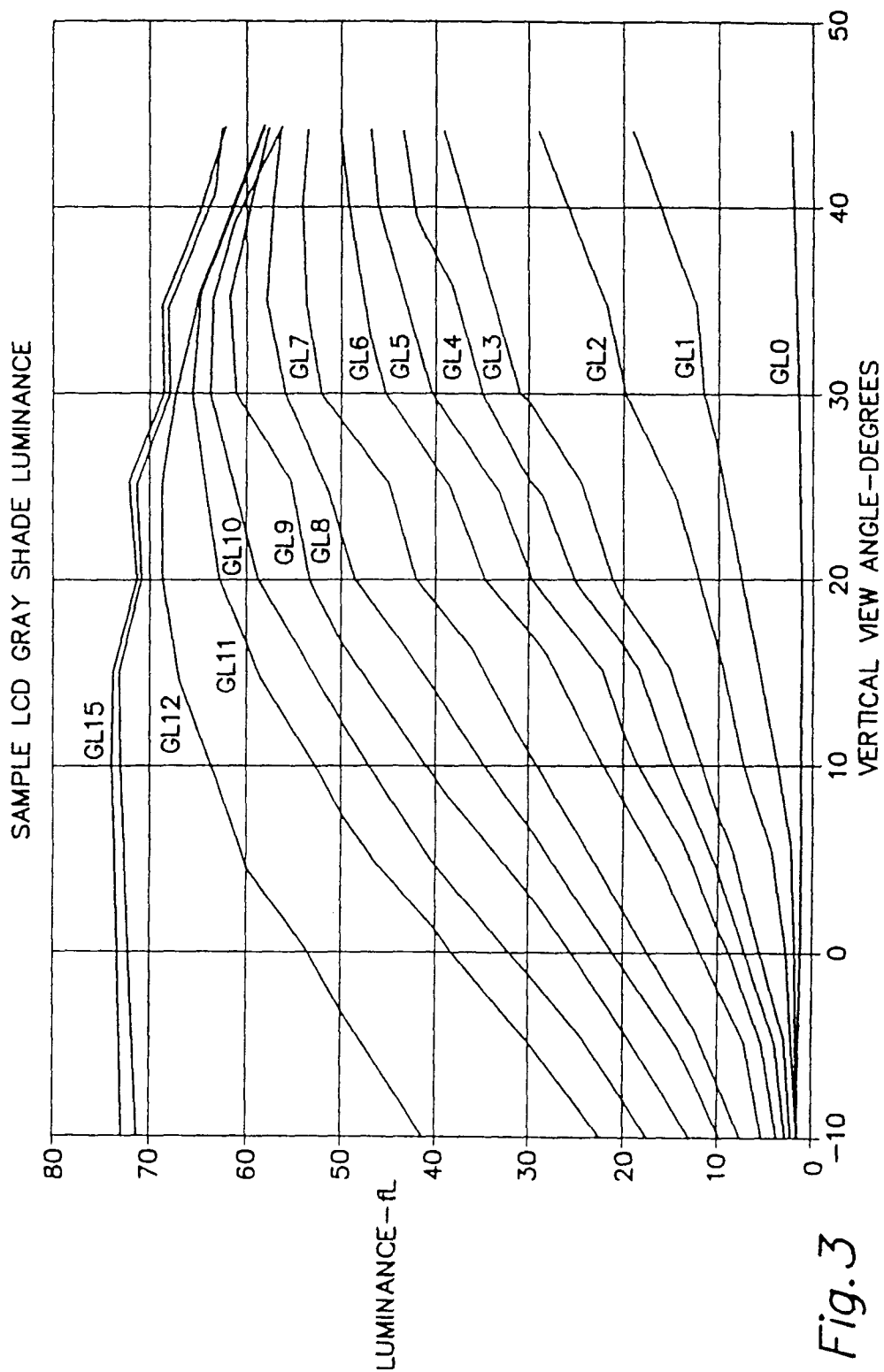
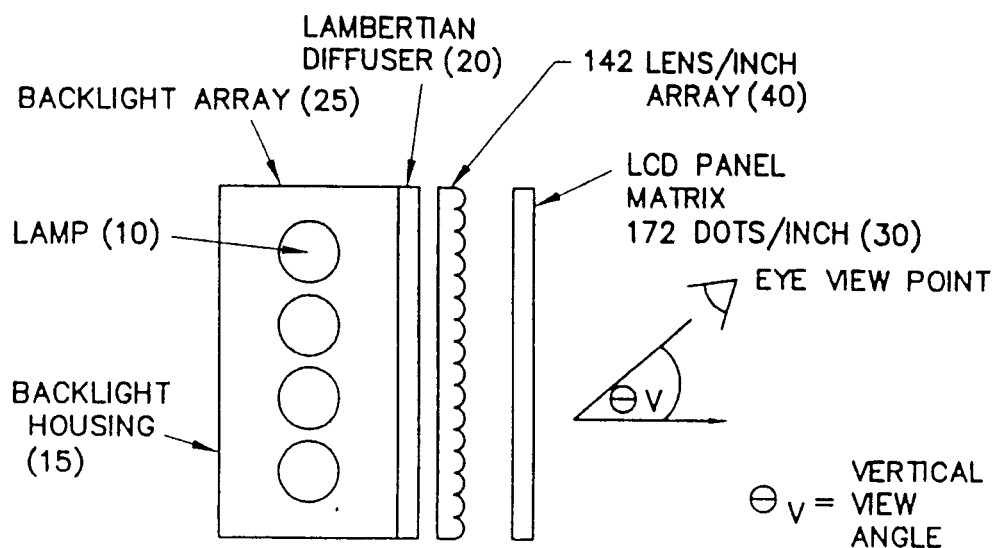


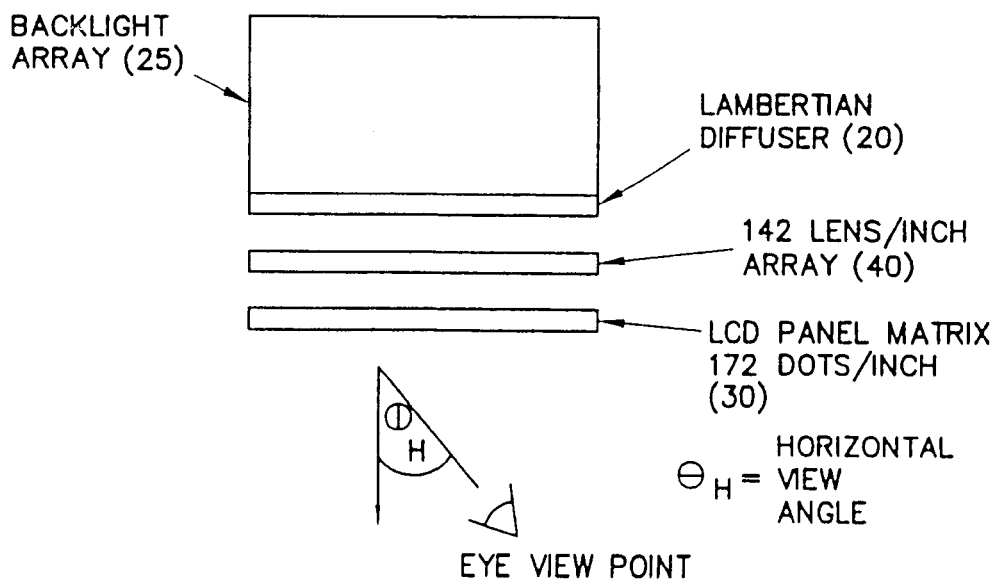
Fig. 3

HONEYWELL INC.
A6213491 US DEJ
PAGE 4/11



SINGLE CYLINDRICAL LENS ARRAY

Fig. 4A



SINGLE CYLINDRICAL LENS ARRAY

Fig. 4B

HONEYWELL INC.
A8213491 US DEJ
PAGE 5/11

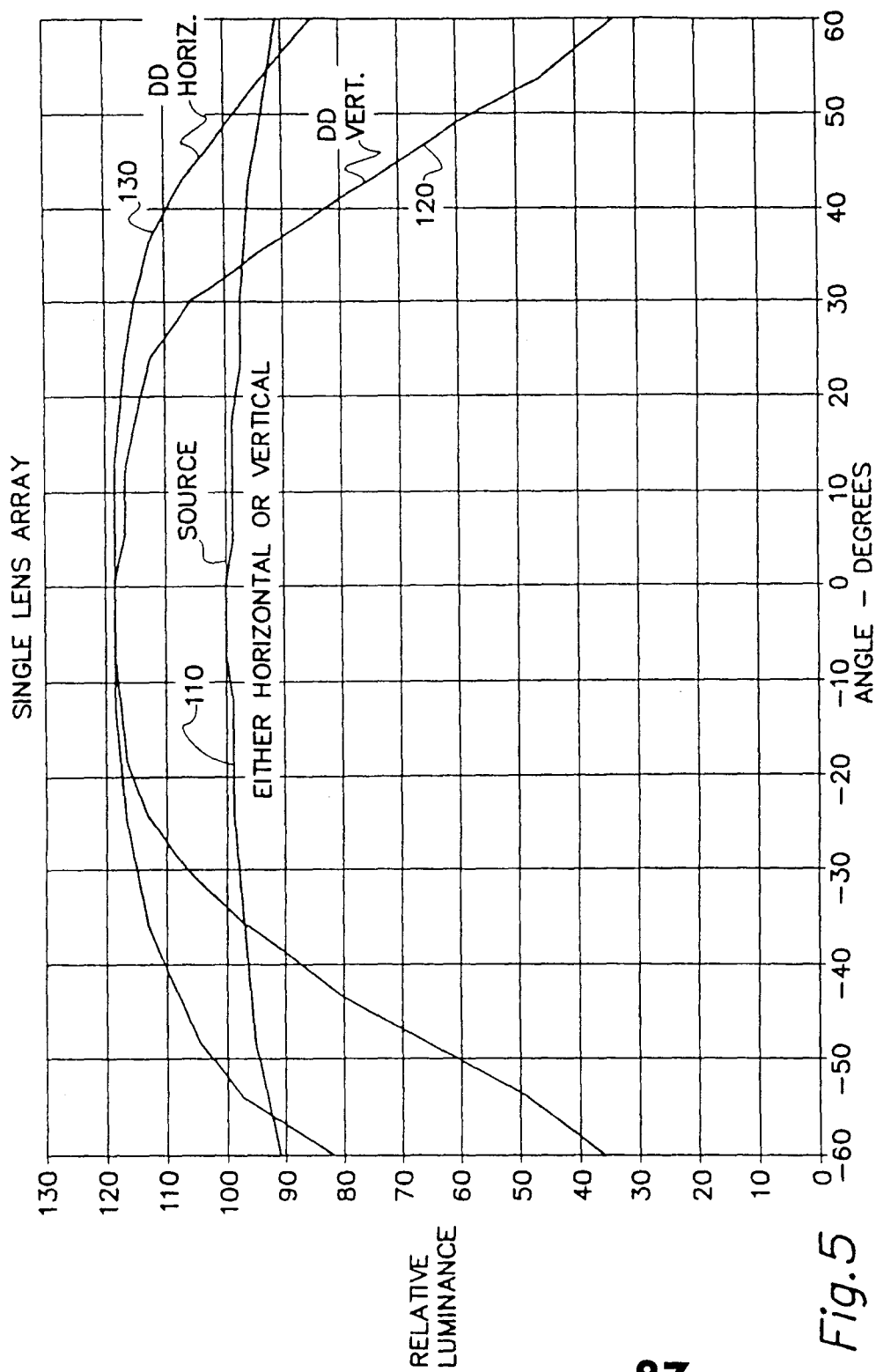


Fig.5

HONEYWELL INC.
A6215491 US DEJ
PAGE 6/11

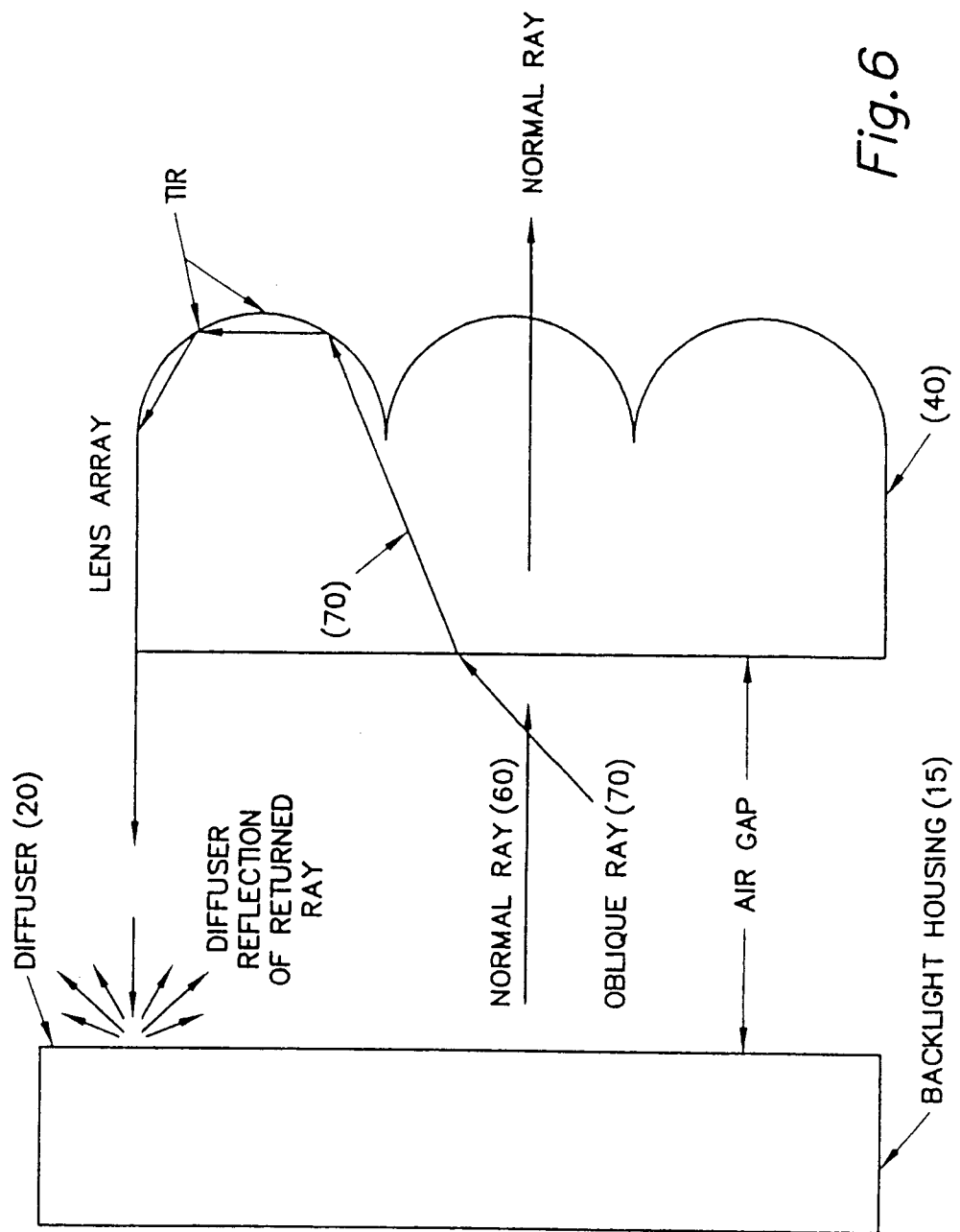


Fig. 6

HONEYWELL INC.
A6213491 US, DEJ
PAGE 7/11

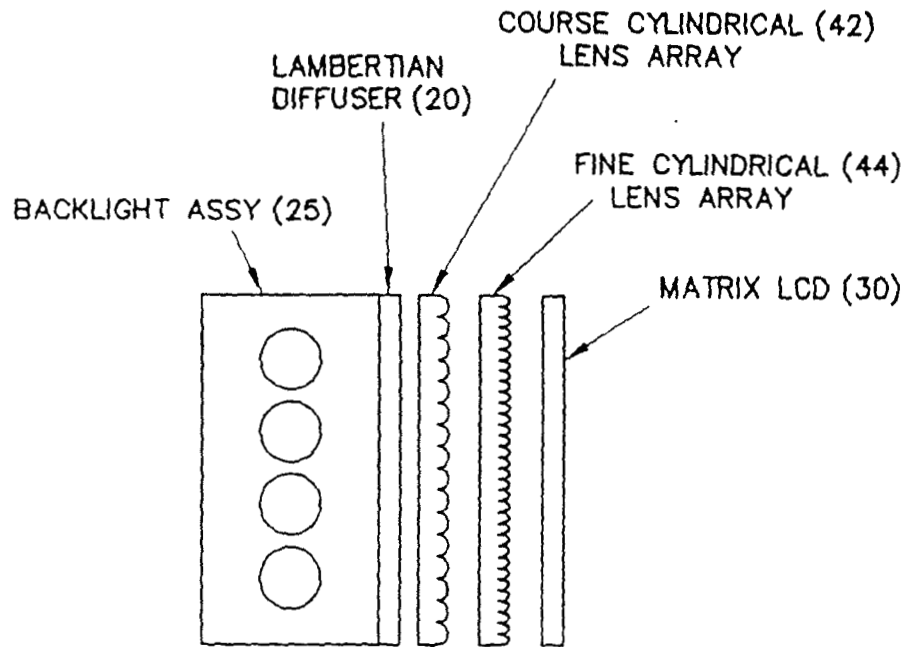


Fig. 7 PREFERRED EMBODIMENT

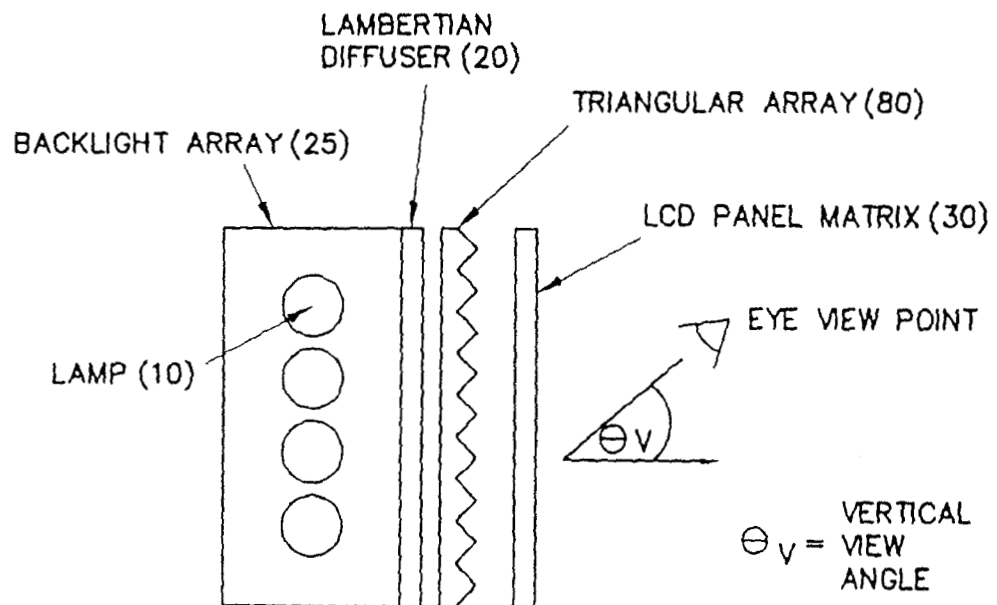


Fig. 10 TRIANGULAR LENS ARRAY

HONEYWELL INC.
A6213491 US DEJ
PAGE 8/11

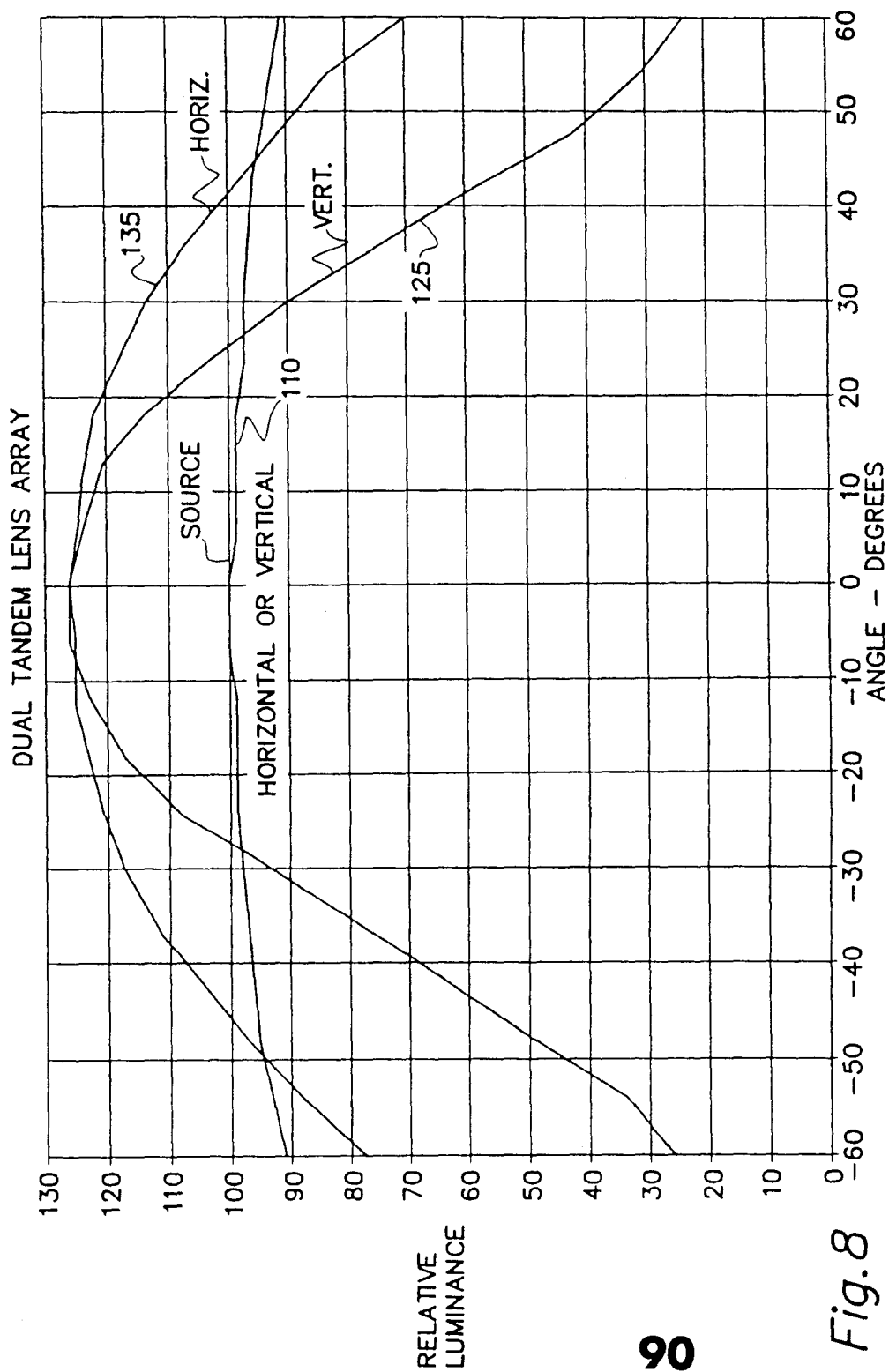


Fig. 8

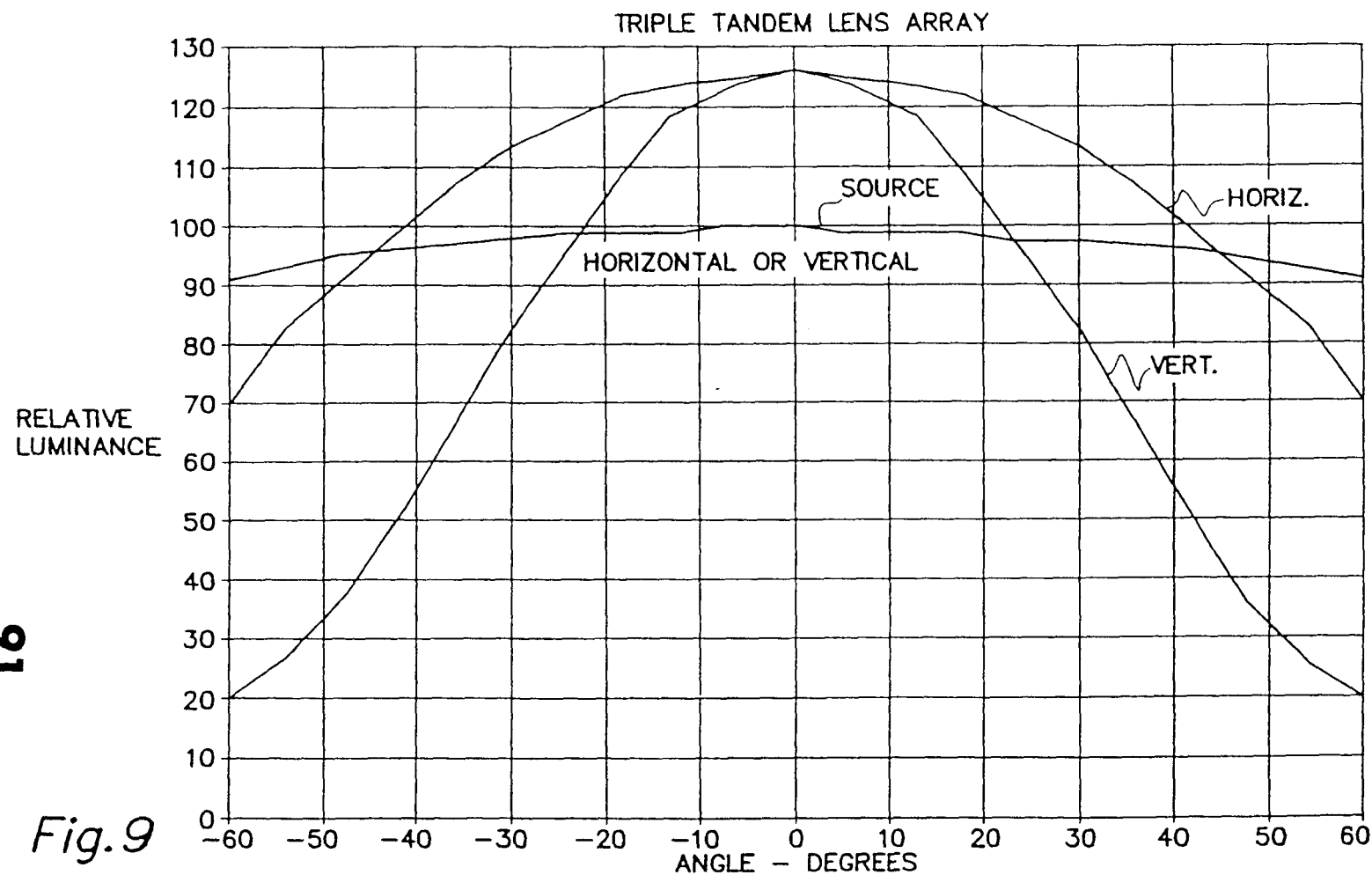


Fig. 9

HONEYWELL INC
AB213101 US DEU
PAGE 9/11

HONEYWELL INC.
A6213491 US DEJ
PAGE 10/11

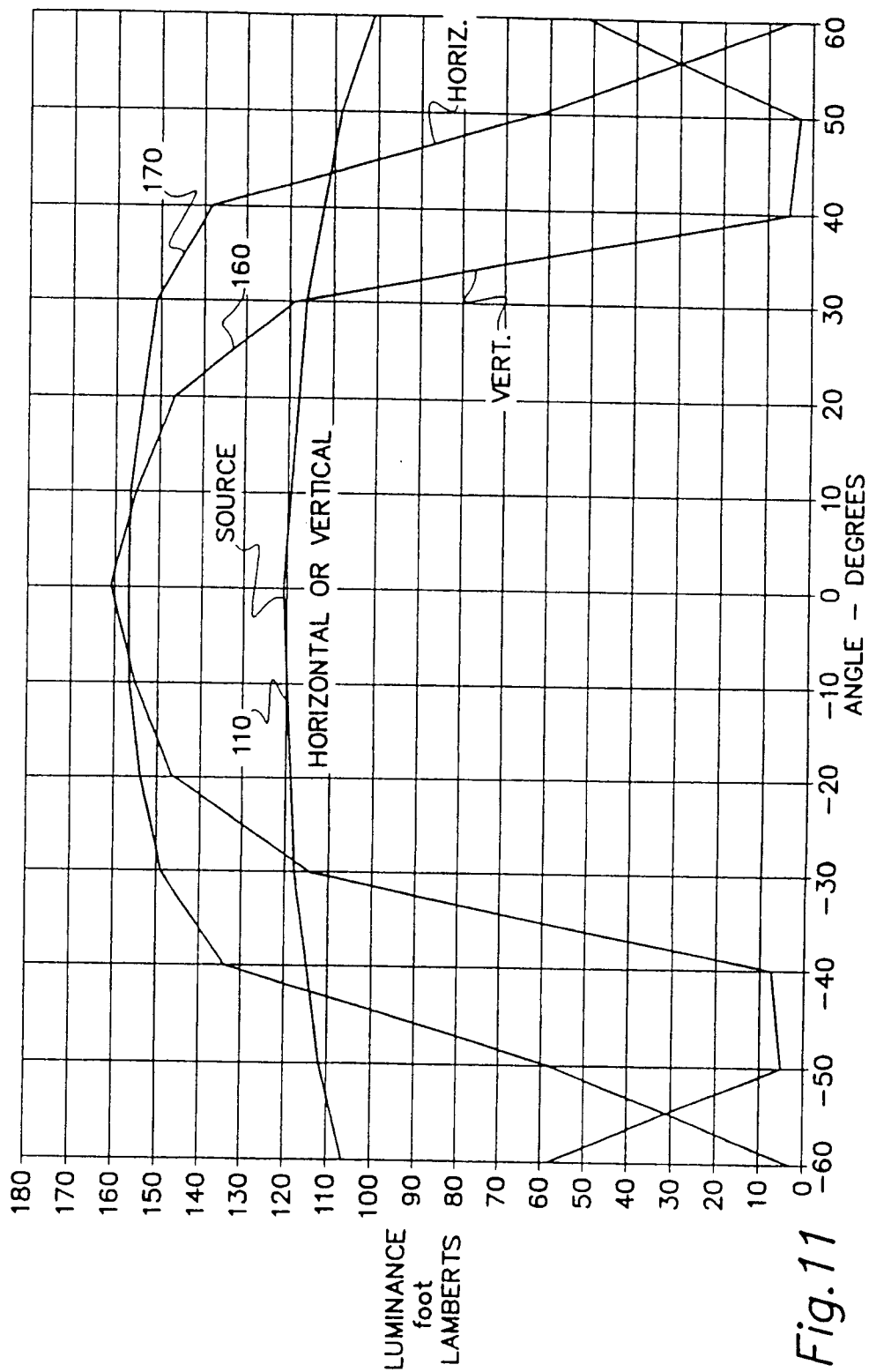


Fig. 11

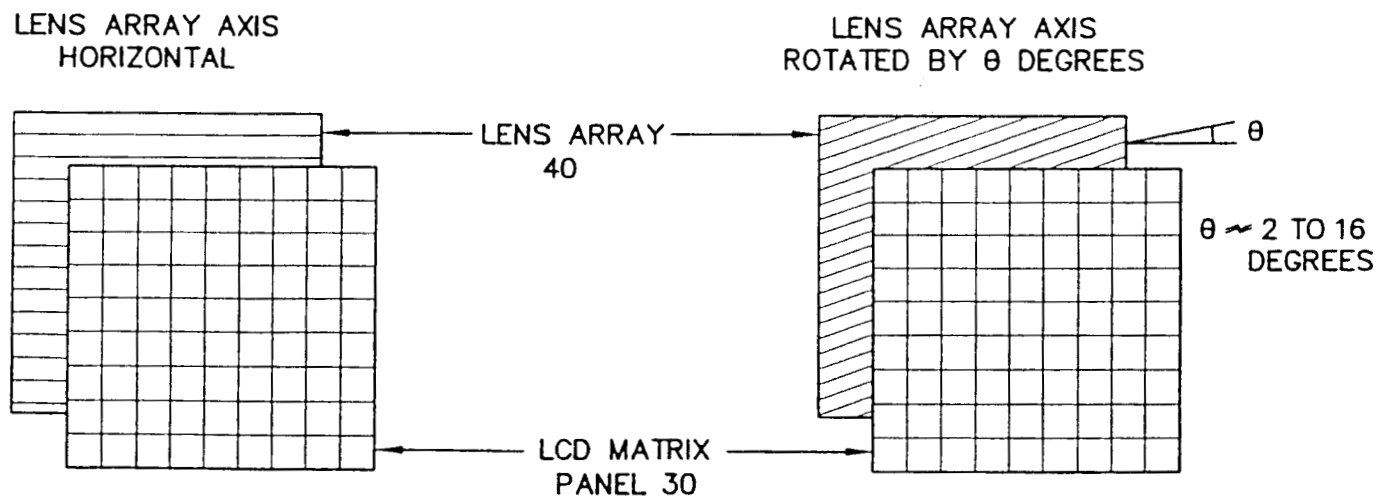


Fig.12

HONEYWELL INC.
AG21349T US, DE, J
PAGE 11/11


**UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office**

 Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.
07/011,547	07/09/92	MC CARTNEY	R AS210491

4102/0924

 DALE E. JEPSEN
HONEYWELL INC.
21,111 N. 19TH AVENUE, DV9L
PHOENIX, AZ 85027

MAIL H	
EXAMINER	
ART UNIT	PAPER NUMBER
2504	11

DATE MAILED: 09/24/93

NOTICE OF DRAWING REQUIREMENTS

☐ The PTO delayed in providing a commercial bonded draftsman with drawings from the above-identified application. The delay prevented the draftsman from filing corrected drawings within the response period set in the Notice of Allowability mailed _____. Hence, said response period is hereby vacated. THE SHORTENED STATUTORY PERIOD FOR RESPONSE to comply with the requirement for drawing corrections is set to EXPIRE ONE MONTH FROM THE DATE OF THIS LETTER. Failure to comply will result in the ABANDONMENT of this application. Extensions of time may be obtained under the provisions of 37 CFR 1.136(a) by filing the appropriate request and fee before the end of the six month statutory period for response.

☒ Corrected/substituted drawings for the above-identified application, received in the PTO on 8-27-93 are still considered informal for the reason(s) identified on the attached Form PTO-948.

☒ Applicant has the time remaining in the response period set in the Notice of Allowability or Notice of Drawing Requirements mailed 7-19-93 to overcome the objections raised in the attached Form PTO-948. This response period may be extended under the provisions of 37 CFR 1.136(a) by filing the appropriate request and fee before the end of the six month statutory period for response.

☐ The PTO delayed in reviewing the corrected drawings. Applicant is given ONE month time limit from the date of this letter to provide corrected drawings. NO EXTENSION OF THIS TIME LIMIT MAY BE GRANTED UNDER EITHER 37 CFR 1.136(a) or (b). See MPEP 714.03. However, the response period set in the Notice of Allowability or Notice of Drawing Requirements mailed _____ may be extended under the provisions of 37 CFR 1.136(a) by filing the appropriate request and fee before the end of the six month statutory period for response.

☐ Corrected/substituted drawings for the above-identified application received in the PTO on _____ were submitted outside of the period for response set in the Notice of Allowability or Notice of Drawing Requirements mailed _____. This application will become abandoned unless applicant obtains an extension of time under the provisions of 37 CFR 1.136(a) by filing the appropriate request and fee before the end of the six month statutory period for response.

ATTACHMENT: PTO-948

94

 R. Willis 9-23-93
PATENT AND TRADEMARK OFFICE DATE

PTO FORM 948
(REV. 7-82)U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

ATTACHMENT TO PAPER NUMBER

11

GROUP

APPLICATION NUMBER

911,547

NOTICE OF DRAFTSPERSON'S PATENT DRAWING REVIEW

THE PTO DRAFTSMEN REVIEW ALL ORIGINALLY FILED DRAWINGS REGARDLESS OF WHETHER THEY WERE DESIGNATED AS INFORMAL OR FORMAL. ADDITIONALLY, THE PATENT EXAMINER WILL ALSO REVIEW THE DRAWINGS FOR COMPLIANCE WITH THE REGULATIONS.

The drawings filed

8-27-93

A. ☐ are approved by the draftsman.

B. ☒ are objected to by the draftsman under 37 CFR 1.84 for the reason(s) checked below. The examiner will require submission of new, corrected drawings at the appropriate time. Corrected drawings must be submitted according to the instructions listed on the back of this Notice.

1. Paper and ink. 37 CFR 1.84(a)

☐ Sheet(s) _____ Poor.

2. Size of Sheet and Margins. 37 CFR 1.84(b)

Acceptable Paper Sizes and Margins

Margin	Paper Size		
	8 1/2 by 14 inches	8 1/2 by 13 inches	DIN size A4 21 by 29.7 cm.
Top	2 inches	1 inch	2.5 cm.
Left	1/4 inch	1/4 inch	2.5 cm.
Right	1/4 inch	1/4 inch	1.5 cm.
Bottom	1/4 inch	1/4 inch	1.0 cm.

☒ Proper Size Paper Required.
All Sheets Must be Same Size.

Sheet(s) *are all oversized*

☒ Proper Margins Required.

Sheet(s) *for all sheets*☐ TOP ☐ RIGHT☐ LEFT ☐ BOTTOM

3. Character of Lines. 37 CFR 1.84(c)

☐ Lines Pale or Rough and Blurred.

Fig(s) _____

☐ Solid Black Shading Not Allowed.

Fig(s) _____

4. ☐ Photographs Not Approved.

5. Hatching and Shading. 37 CFR 1.84(d)

☐ Shade Lines are Required.

Fig(s) _____

☐ Criss-Cross Hatching Not Allowed.

Fig(s) _____

☐ Double Line Hatching Not Allowed.

Fig(s) _____

☐ Parts in Section Must be Hatched.

Fig(s) _____

6. Reference Characters. 37 CFR 1.84(f)

☐ Reference Characters Poor or Incorrectly Sized.

Fig(s) _____

☐ Reference Characters Placed Incorrectly.

Fig(s) _____

7. Views. 37 CFR 1.84(i) & (j)

☐ Figures Must be Numbered Properly.☐ Figures Must Not be Connected.

Fig(s) _____

8. ☐ Identification of Drawings. 37 CFR 1.84(1)

Extraneous Matter or Copy Machine Marks Not Allowed. Fig(s) _____

9. ☐ Changes Not Completed from Prior

PTO-948 dated _____

☒ Comments:

Ref: Proper size Paper required above. you must use correct measurement.

Descriptive matter obj, also descriptive title. Delete letter legends all figures, that are not needed and use lead lines, also delete arrow heads.

Telephone Inquiries concerning this review should be directed to the Chief Draftsman at telephone number (703) 305-8404.

R. Wallis
Reviewing Draftsman

9-23-93
Date

Note: Any objection to the drawings made by the examiner will be communicated separately in an office action.

PART B—ISSUE FEE TRANSMITTAL

MAILING INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE. Blocks 2 through 6 should be completed only if appropriate. Further correspondence including the Issue Fee Receipt, the Patent, advances orders and notification of maintenance fees will be mailed to addressee red in Block 1 unless you direct otherwise, by: (a) specifying a new correspondence address in Block below; or (b) providing the PTO with a separate ADDRESS* for maintenance fee notifications with the payment of Issue Fee or thereafter. See reverse for Certificate of Mailing.

1. CORRESPONDENCE ADDRESS

DALE E. JEPSEN
HONEYWELL INC.
21,111 N. 19TH AVENUE, DPH-1
PHOENIX, AZ 85027

2. INVENTOR(S) ADDRESS CHANGE (Complete only if there is a change)

INVENTOR'S NAME

Street Address

City, State and ZIP Code

CO-INVENTOR'S NAME

Street Address

City, State and ZIP Code

☐ Check if additional changes are on reverse side

3. SERIES CODE/SERIAL NO.

FILING DATE

TOTAL CLAIMS

EXAMINER AND GROUP ART UNIT

DATE MAILED

07/911,547

07/09/92

003

M41, H

2504

07/19/

First Named Applicant

OF INVENTION

DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY

ATTY'S DOCKET NO.

CLASS-SUBCLASS

BATCH NO.

APPLN. TYPE

SMALL ENTITY

FEE DUE

DATE DUE

0

A6213491

359-040,000

093

UTILITY

NO

\$1,170.00

10/12/93

3. Correspondence address change (Complete only if there is a change)

4. For printing on the patent front page, list the names of not more than 3 registered patent attorneys or agents OR alternatively, the name of a firm having as a member a registered attorney or agent. If no name is listed, no name will be printed.

1 DALE E. JEPSEN

2 A. MEDVED

3

DS20239

09/09/93

07911547

DO NOT USE THIS SPACE

08-2727

020

142

1,170.00CH

08-2727

020

561

30.00CH

5. ASSIGNMENT DATA TO BE PRINTED ON THE PATENT (print or type)

(1) NAME OF ASSIGNEE:

HONEYWELL INC.

(2) ADDRESS: (CITY & STATE OR COUNTY)

MINNEAPOLIS, MN

(3) STATE OF INCORPORATION, IF ASSIGNEE IS A CORPORATION

DELAWARE

A. ☐ This application is NOT assigned:☐ Assignment is being previously submitted to the Patent and Trademark Office.☐ Assignment is being submitted under separate cover. Assignments should be directed to Box ASSIGNMENTS.

PLEASE NOTE: Unless an assignee is identified in Block 5, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the PTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

6a. The following fees are enclosed:

☐ Issue Fee ☐ Advanced Order - # of Copies (Minimum of 10)

6b. The following fees should be changed to:

DEPOSIT ACCOUNT NUMBER 08-2727

(ENCLOSED PART C)

☒ Issue Fee ☐ Advanced Order - # of Copies (Minimum)☒ Any Deficiencies in Enclosed Fees

The COMMISSIONER OF PATENTS AND TRADEMARKS is requested to apply the Issue Fee to the application identified above.

(Signature of party in interest of record)

DALE E. JEPSEN

31,379

08/27/93

NOTE: The Issue Fee will not be accepted from anyone other than the applicant, a registered attorney or agent, or the assignee or other party in interest as shown by the records of the Patent and Trademark Office.

TRANSMIT THIS FORM WITH FEE CERTIFICATE OF MAILING ON SEPARATE

**Certificate of Mailing**

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to:

Box ISSUE FEE
Commissioner of Patents and Trademarks
Washington, D.C. 20231

on 08/27/93

(Date)

(Signature)

JOANNA JOHNSON
(Typed or Printed Name)

08/27/93
(Date)

Note: If this certificate of mailing is used, it can only be used to transmit the Issue Fee. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing.

This form is estimated to take 20 minutes to Complete. Time will vary depending upon the needs of the individual applicant. Any comments on the amount of time you require to complete this form should be sent to the Office of Management and Organization, Patent and Trademark Office, Washington, D.C. 20231 and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, D.C. 20503.



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

DOCKET NO. A6213491

PATENT

Re application of: RICHARD MCCARTNEY ET AL

Serial No.: 07/911,547

Group No.: 2504

Filed: 0 / 07/09/92

Examiner: H. MAI

For: "DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY"

Date of mailing of PTOL 85, entitled "Notice of Allowance and Base Issue Fee Due" 10/19/93

Issue Batch No. 098

BOX ISSUE FEE

Commissioner of Patents and Trademarks

Washington, D.C. 20231

**TRANSMITTAL OF NEW DRAWING(S) TO CORRECT INFORMALITIES
WITHIN THREE MONTH PERIOD OF RESPONSE SET IN NOTICE OF
ALLOWABILITY (PTOL 37)**

NOTE: Applicant may correct any informalities in the drawings made by the Draftsman's objections on PTO-948 by filing new drawings with the changes incorporated therein. If the filing of the drawings are delayed until receipt of the "Notice of Allowability" (PTOL-37) the new drawings **MUST** be filed within the **THREE MONTH** shortened statutory period set for response in the "Notice of Allowability" (PTOL-37). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

NOTE: Corrected drawings as well as the issue fee should be addressed to: Box Issue Fee. Notice of November 30, 1990 (1122 O.G. 571 to 591).

NOTE: Applicant is required to submit **ACCEPTABLE** corrected drawings within the three month shortened statutory period set in the "Notice of Allowability" (PTOL-37). Within that three month period, two weeks should be allowed for review by the Office of the correction. If a correction is determined to be unacceptable by the Office, applicant must arrange to have an acceptable correction re-submitted within the original three month period to avoid the necessity of obtaining an extension of time and of paying the extension fee. **THEREFORE, APPLICANT SHOULD FILE CORRECTED DRAWINGS AS SOON AS POSSIBLE.** Notice of January 14, 1985 (1051 O.G. 3).

CERTIFICATE OF MAILING (37 CFR 1.8)

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to the: Commissioner of Patents and Trademarks, Washington, D.C. 20231.

JOANNA JOHNSON

(Type or print name of person mailing paper)

Date: 10/04/93


(Signature of person mailing paper)

(Transmittal of New Drawing(s) to Correct Informalities Within Three Month Period of Response Set in Notice of Allowability (PTOL 37) [5-2.1]—page 1 of 2)

SUBMISSION OF DRAWING(S)

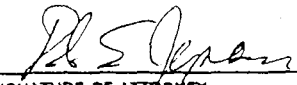
1. To correct the informalities in the drawings as noted in the Draftsman's objection(s) on PTO-948 applicant submits herewith new drawing(s) for this application. Number of sheets of drawings submitted ELEVEN (11)

NOTE: According to 37 CFR 1.84(1), identifying indicia (such as the attorney's docket number, inventor's name, number of sheets, etc.) not to exceed 2 3/4 inches may be placed in a centered location between the side edges within three-fourths inch of the top of the edge. Either this marking technique on the front of the drawing or the placement of this information on the back of the drawing is acceptable. However, for identification of the application number, the PTO prefers that it be placed on the front. Notice of September 30, 1986 (1070 O.G. 47-59, 54-5).

2. The three month period of response set in the Notice of Allowability (PTOL 37) expires on 10/19/93 and this submission is on or before this expiry date.

Reg. No.: 31,379

Tel. No.: (602) 436-1336


SIGNATURE OF ATTORNEY

DALE E. JEPSEN

Type or print name of attorney

P.O. Address

PATENT LAW OFFICE
HONEYWELL INC.
P. O. BOX 21,111
PHOENIX, AZ 85036

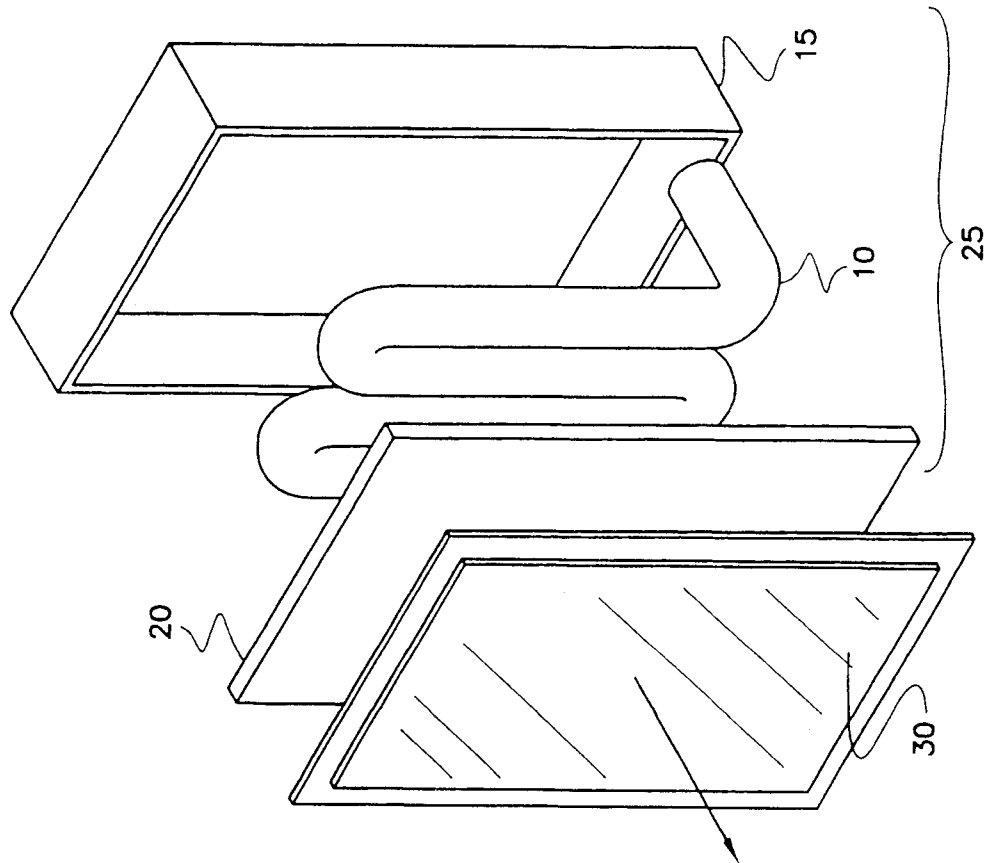
99

HONEYWELL INC.
A6213491 US DEJ
PAGE 1/11

5280371

APPROVED	D.G. FIG. 7
BY	CLASS SUBCLASS
DRAFTSMAN	353 40

Fig. 1
PRIOR ART



HONEYWELL INC.
A6213491 US DEJ
PAGE 2/11

APPROVED	O.G. FIG.	
BY	CLASS	SUBCLASS
DRAFTSHAN		

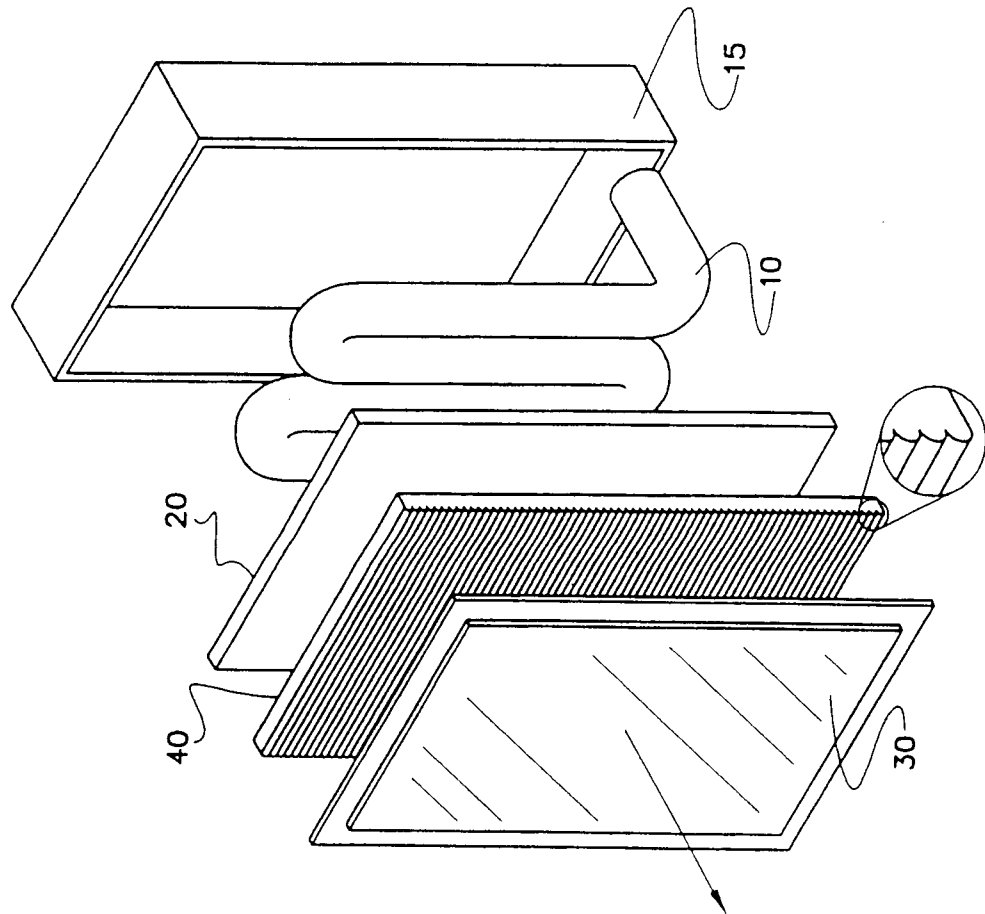
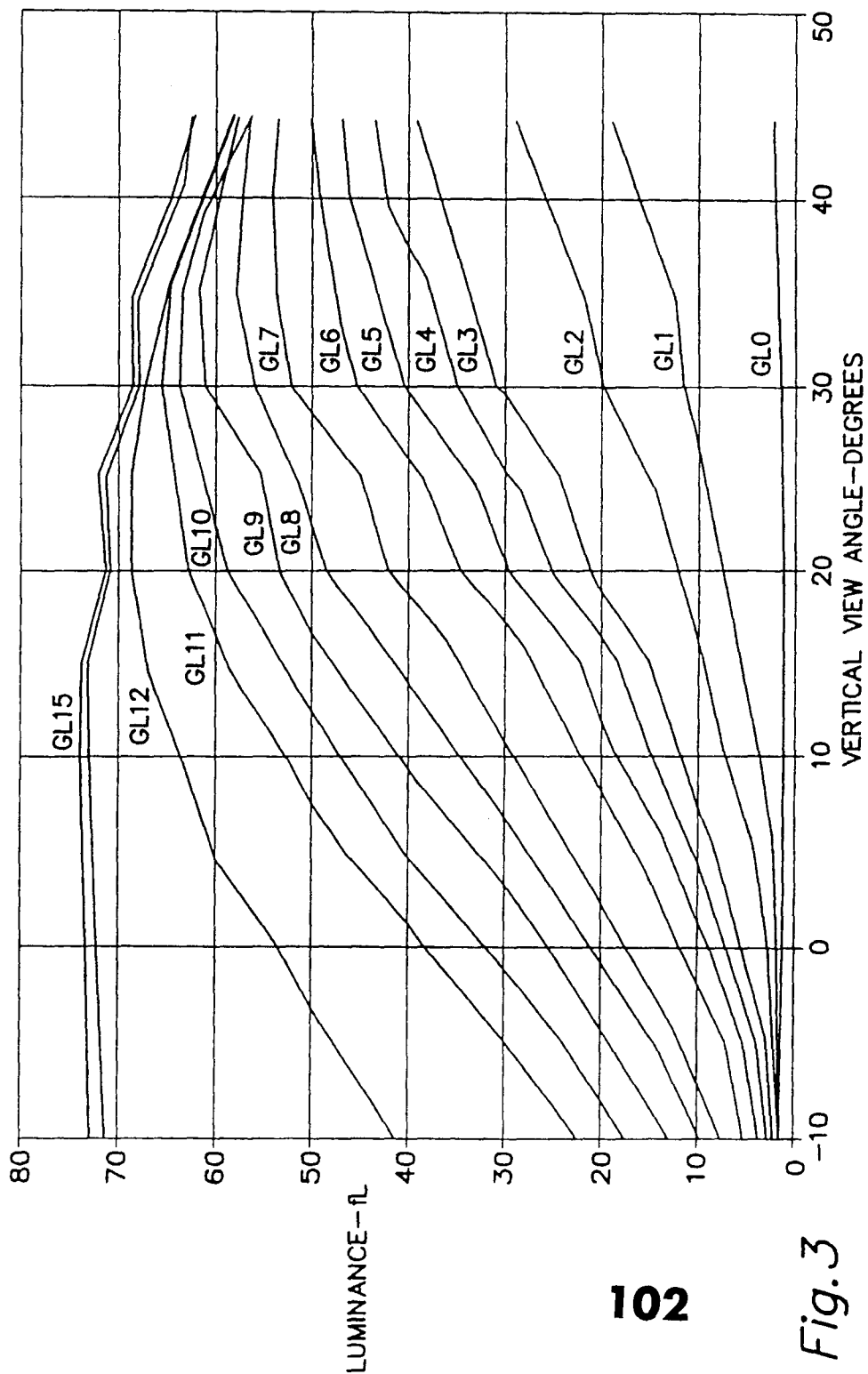


Fig.2

HONEYWELL INC.
 AB213491 US DEJ
 PAGE 3/11

APPROVED	FIG.
BY	CLASS
DRAFTSMAN	SUBCLASS



102

Fig. 3

HONEYWELL INC.
A6213491 US DEJ
PAGE 4/11

APPROVED	0.0. FIG.
BY	CLASS SUBCLASS
DRAFTSMAN	

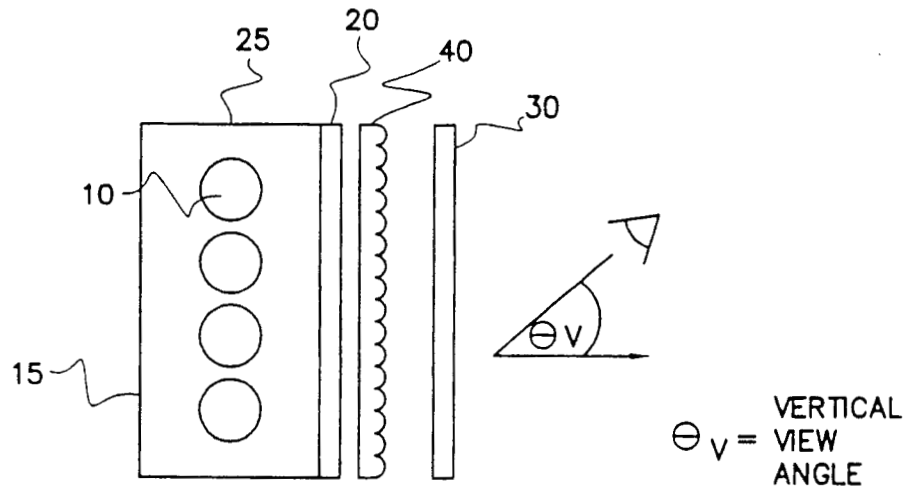


Fig. 4A

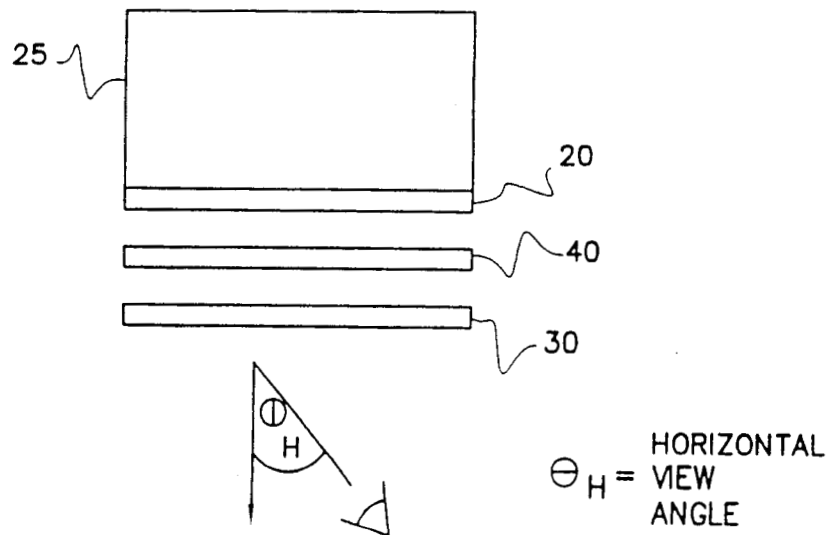


Fig. 4B

HONEYWELL INC.
A6213491 US DEJ
PAGE 5/11

APPROVED	O.G. FIG.	
BY	CLASS	SUBCLASS
DRAFTSMAN		

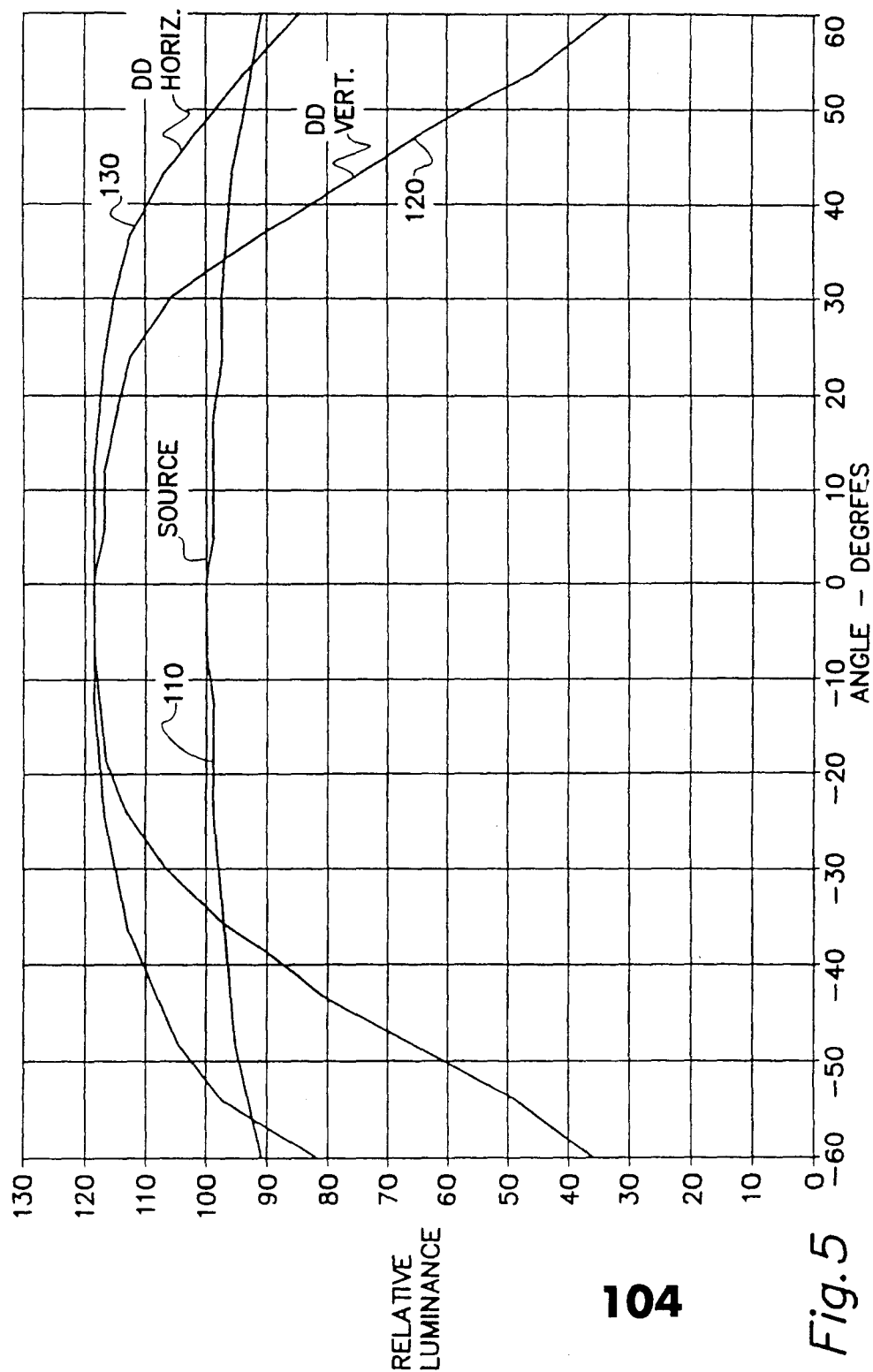
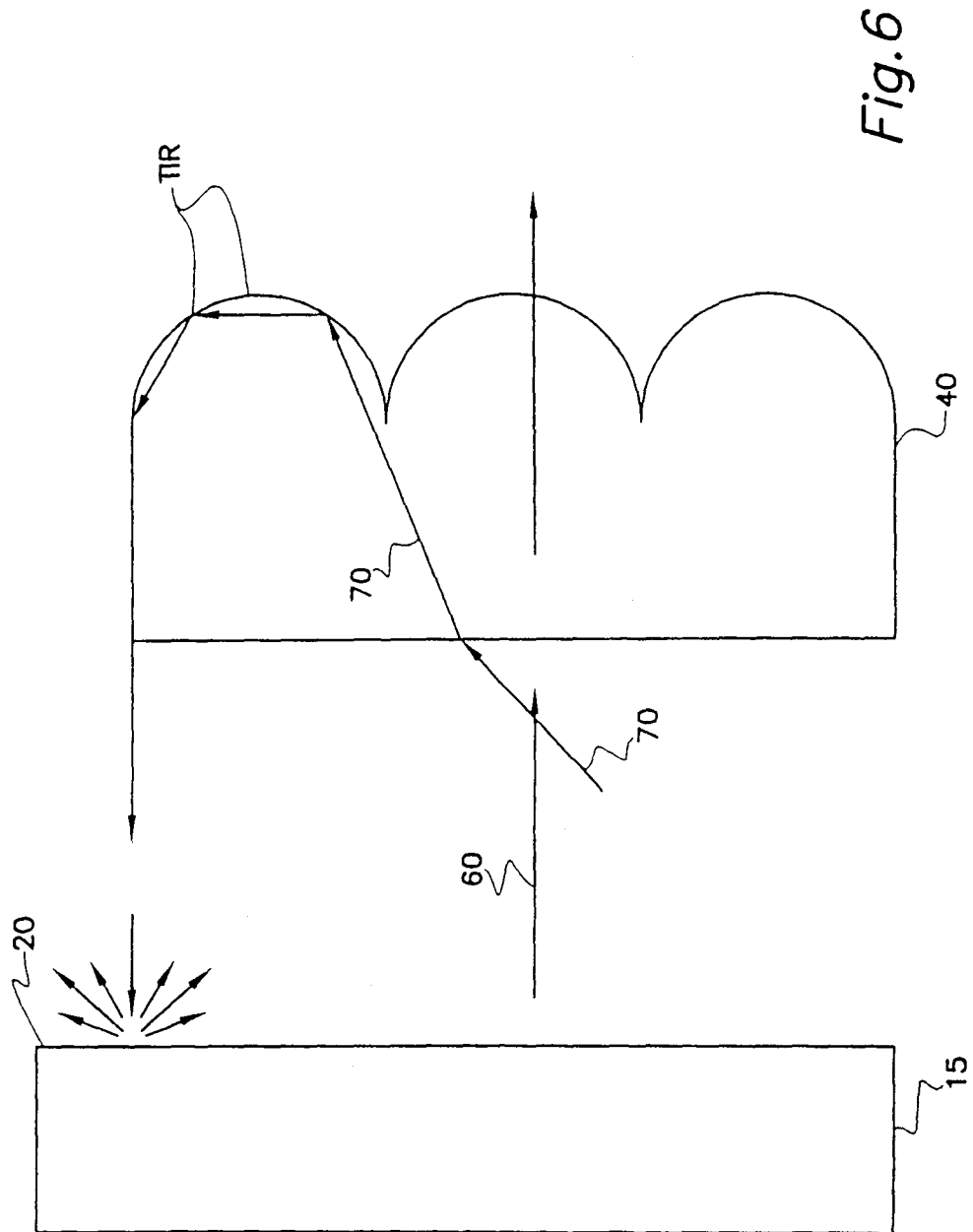


Fig. 5

HONEYWELL INC.
 AB213491 US DEJ
 PAGE 8/11

APPROVED	O.G. FIG.
BY	CLASS SUBCLASS
DRAFTSMAN	



HONEYWELL INC.
 AB213491 US DEJ
 PAGE 7/11

APPROVED	D.G. FIG. 7	
	CLASS	SUBCLASS
BY	35 90	
DRAFTSMAN		

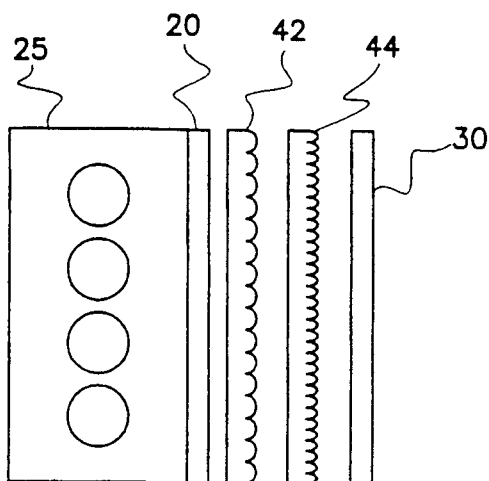
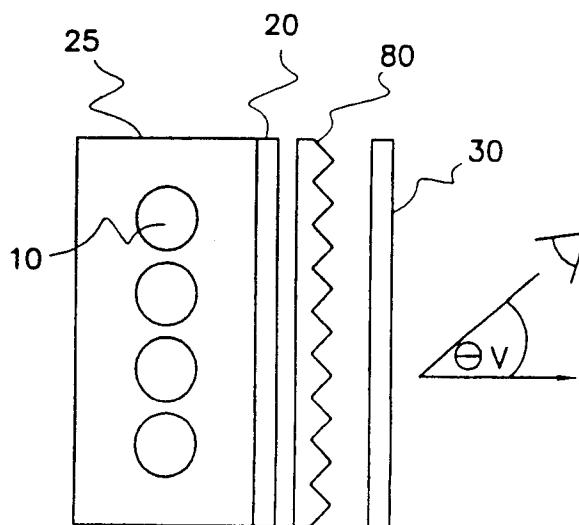


Fig. 7



Θ_v = VERTICAL
 VIEW
 ANGLE

Fig. 10

HONEYWELL INC.
A6213491 US DEJ
PAGE 8/11

APPROVED	O.G. FIG.	
BY	CLASS	SUBCLASS
DRAFTSMAN		

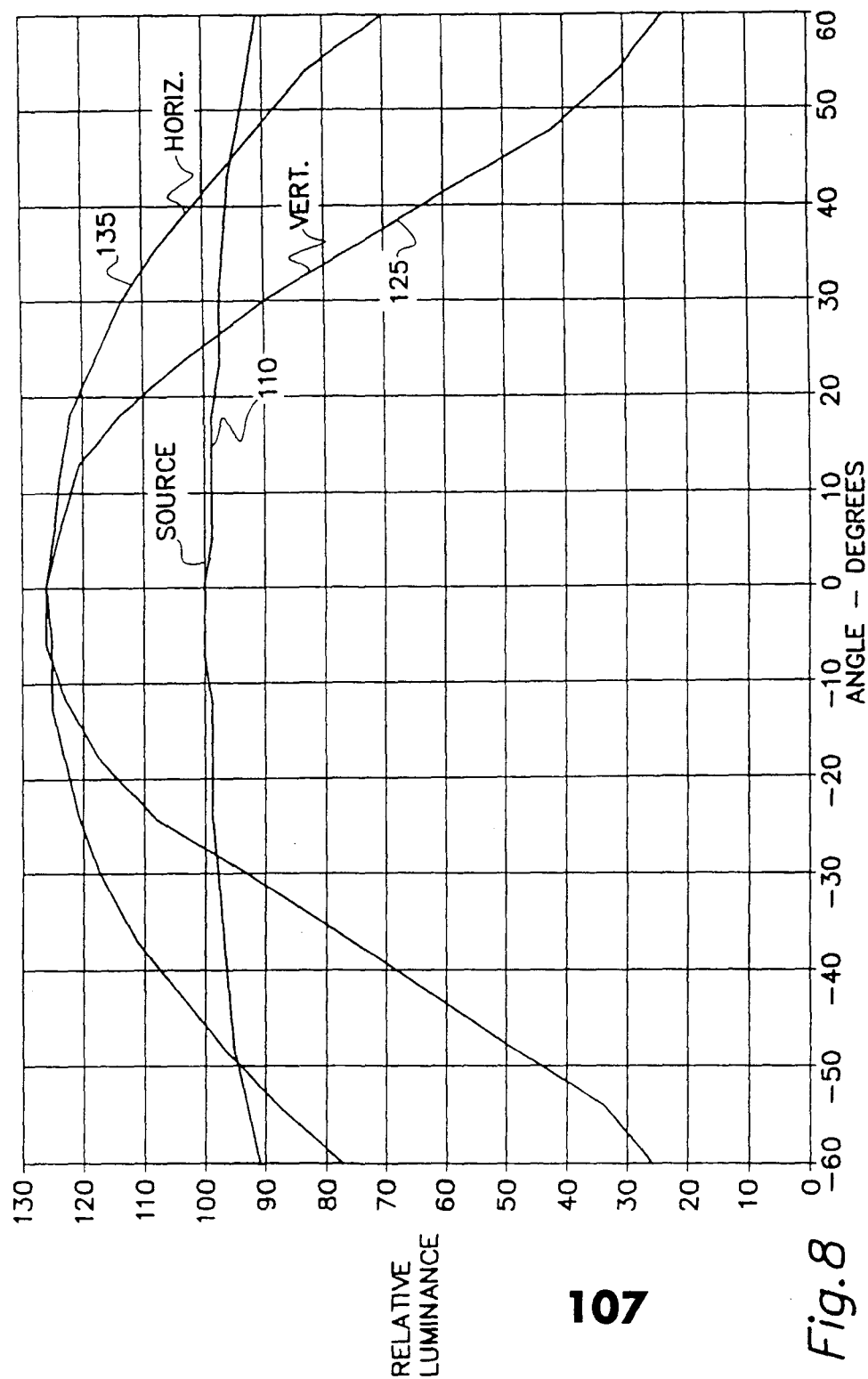
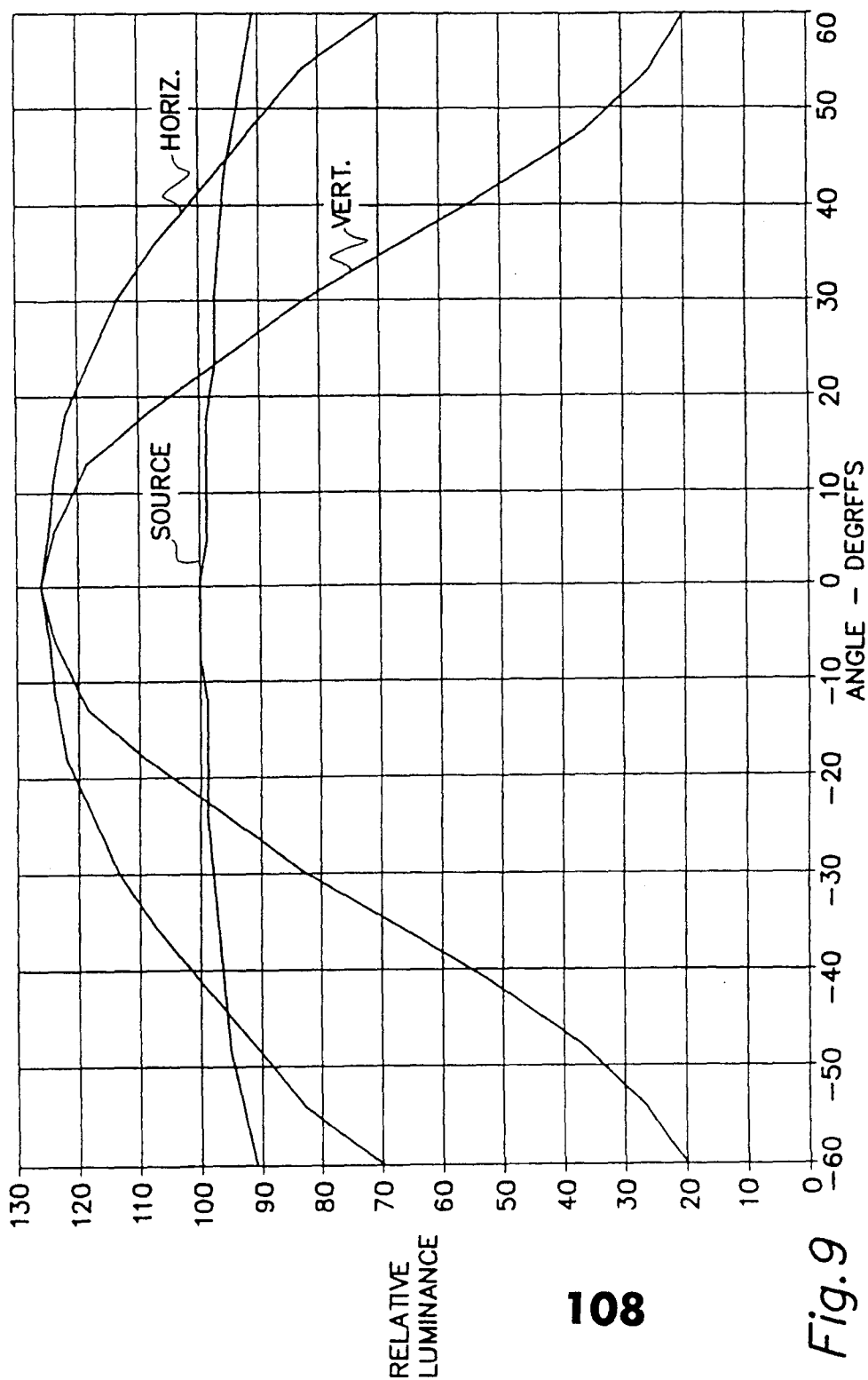


Fig.8

APPROVED	D.C. FIG.	
BY	CLASS	SUBCLASS
DRAFTSMAN		

HONEYWELL INC.
A6213491 US DEJ
PAGE 9/11



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Fig. 9

HONEYWELL INC.
A6215491 US DEJ
PAGE 10/11

APPROVED	O.G. FIG.	
BY	CLASS	SUBCLASS
DRAFTSMAN		

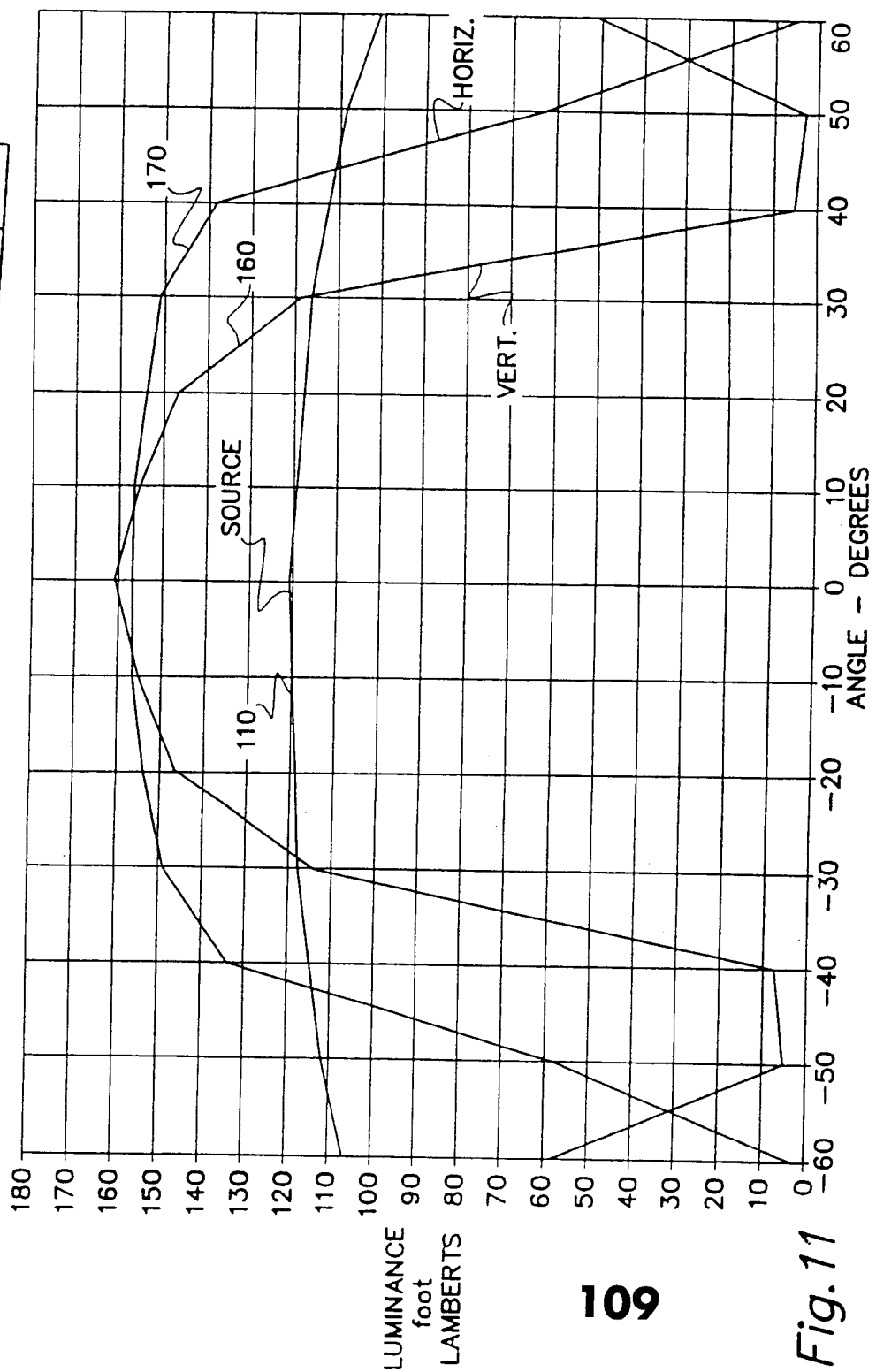


Fig. 11

APPROVED	O.G. FIG.		
BY	CLASS	SUBCLASS	
DRAFTSMAN			

HONEYWELL INC.
A6213491 US, DE, J
PAGE 11/11

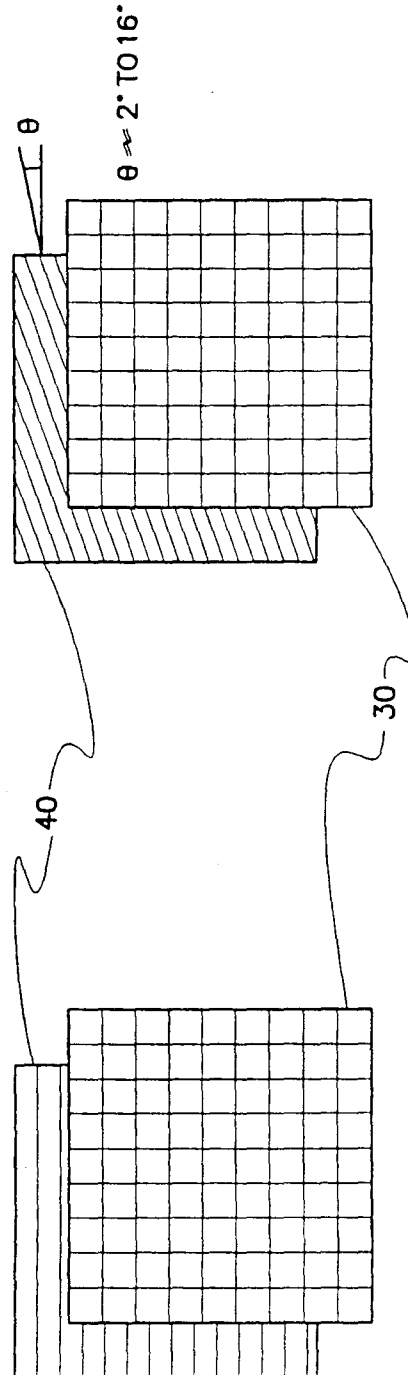


Fig.12

The
United
States
of
America



PTO UTILITY GRANT

Paper Number 14

The Commissioner of Patents
and Trademarks

*Has received an application for a patent
for a new and useful invention. The title
and description of the invention are en-
closed. The requirements of law have
been complied with, and it has been de-
termined that a patent on the invention
shall be granted under the law.*

Therefore, this

United States Patent

*Grants to the person or persons having
title to this patent the right to exclude
others from making, using or selling the
invention throughout the United States
of America for the term of seventeen
years from the date of this patent, sub-
ject to the payment of maintenance fees
as provided by law.*

Bence Lehman

Commissioner of Patents and Trademarks

Dorinda J. Morton
Attest

PTO-1584

87 911547

PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

LA10289 07/20/92 07911547

00-2727 010 101

690.0000 A6213491

112

PATENT APPLICATION FEE DETERMINATION RECORD						Application or Docket Number	
Effective October 1, 1992							
CLAIMS AS FILED - PART I						SMALL ENTITY OR OTHER THAN SMALL ENTITY	
(Column 1)		(Column 2)		(Column 3)		(Column 4)	
FOR	NUMBER FILED	NUMBER EXTRA	RATE	FEE	OR	RATE	FEE
BASIC FEE	[REDACTED]		[REDACTED]	\$355.00	OR	[REDACTED]	\$710.00
TOTAL CLAIMS	minus 20 = *		x\$11=		OR	x\$22=	
INDEPENDENT CLAIMS	minus 3 = *		x 37=		OR	x 74=	
MULTIPLE DEPENDENT CLAIM PRESENT			+115=		OR	+230=	
TOTAL					OR	TOTAL	
* If the difference in column 1 is less than zero, enter "0" in column 2							
CLAIMS AS AMENDED - PART II						SMALL ENTITY OR OTHER THAN SMALL ENTITY	
(Column 1)		(Column 2)		(Column 3)		(Column 4)	
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE	ADDITIONAL FEE	OR	RATE
Total	7	Minus 20	=	x\$11=		OR	x\$22=
Independent	1	Minus 3	=	x 37=		OR	x 74=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM			+ 115=		OR	+230=	
TOTAL					OR	TOTAL	
ADDIT. FEE					OR	ADDIT. FEE	
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE	ADDITIONAL FEE	OR	RATE
Total	3	Minus 20	=	x\$11=		OR	x\$22=
Independent	2	Minus 3	=	x 37=		OR	x 74=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM			+ 115=		OR	+ 230=	
TOTAL					OR	TOTAL	
ADDIT. FEE					OR	ADDIT. FEE	
AMENDMENT C	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE	ADDITIONAL FEE	OR	RATE
Total		Minus	=	x\$11=		OR	x\$22=
Independent		Minus	=	x 37=		OR	x 74=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM			+115=		OR	+230=	
TOTAL					OR	TOTAL	
ADDIT. FEE					OR	ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
 ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
 *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
 The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

* CRM PTO-875

PATENT APPLICATION FEE DETERMINATION RECORD						Application or Docket Number 911547	
Effective December 16, 1991							
CLAIMS AS FILED - PART I						SMALL ENTITY OR OTHER THAN SMALL ENTITY	
(Column 1)		(Column 2)					
FOR	NUMBER FILED	NUMBER EXTRA		RATE	FEE	RATE	FEE
BASIC FEE					\$ 345.00		\$ 690.00
TOTAL CLAIMS	4	minus 20 =	*	x \$10 =		x \$20 =	
INDEPENDENT CLAIMS	1	minus 3 =	*	x 36 =		x 72 =	
MULTIPLE DEPENDENT CLAIM PRESENT				+ 110 =		+ 220 =	
				TOTAL		TOTAL	670
* If the difference in column 1 is less than zero, enter "0" in column 2							
CLAIMS AS AMENDED - PART II						SMALL ENTITY OR OTHER THAN SMALL ENTITY	
(Column 1)		(Column 2)		(Column 3)			
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE	ADDITIONAL FEE
	Total	*	Minus	**	=	x \$10 =	x \$20 =
	Independent	*	Minus	***	=	x 36 =	x 72 =
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				+ 110 =		+ 220 =
					TOTAL		TOTAL
(Column 1)		(Column 2)		(Column 3)			
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE	ADDITIONAL FEE
	Total	*	Minus	**	=	x \$10 =	x \$20 =
	Independent	*	Minus	***	=	x 36 =	x 72 =
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				+ 110 =		+ 220 =
					TOTAL		TOTAL
(Column 1)		(Column 2)		(Column 3)			
AMENDMENT C		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE	ADDITIONAL FEE
	Total	*	Minus	**	=	x \$10 =	x \$20 =
	Independent	*	Minus	***	=	x 36 =	x 72 =
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				+ 110 =		+ 220 =
					TOTAL		TOTAL
(Column 1)		(Column 2)		(Column 3)			
				TOTAL		TOTAL	
				ADDIT. FEE		ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
 ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
 *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
 The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

PTO 1120		U.S. DEPARTMENT OF COMMERCE- PATENT & TRADEMARK OFFICE										1ST EXAMINER		T. WEST		DATE		7-24-92	
(REV 11/81)		PACE DATA ENTRY CODING SHEET										2ND EXAMINER		DATE					
APPLICATION NUMBER				TYPE APPL		FILING DATE			SPECIAL HANDLING		GROUP ART UNIT		CLASS		SHEETS OF DRAWING				
87 911547				11		070992			0		2504		359		12				
TOTAL CLAIMS		INDEPENDENT CLAIMS		SMALL ENTITY?		FILING FEE			FOREIGN LICENSE		ATTORNEY DOCKET NUMBER								
9		1		0		690			✓		46213491								
CONTINUITY DATA																			
CONTINUITY CODE		STATUS CODE		PARENT APPLICATION SERIAL NUMBER						PARENT PATENT NUMBER						PARENT FILING DATE			
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PCT/FOREIGN APPLICATION DATA																			
FOREIGN PRIORITY CLAIMED		COUNTRY CODE			PCT/FOREIGN APPLICATION SERIAL NUMBER										FOREIGN FILING DATE				
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VERIFIER	332	7-24-92
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INDEX OF CLAIMS

116

Claim	Final	Original	Date
1	7	7	7/12/93
2	8	8	7/12/93
3	9	9	7/12/93
4	10	10	7/12/93
5	11	11	7/12/93
6	12	12	7/12/93
7	13	13	7/12/93
8	14	14	7/12/93
9	15	15	7/12/93
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41	47	47	7/12/93
42	48	48	7/12/93
43	49	49	7/12/93
44	50	50	7/12/93

SYMBOLS

✓ Rejected
= Allowed
- (Through numeral) Cancelled
+ Restricted
N Non-affected
I Interference
A Appeal
O Objected

Claim	Final	Original	Date
51			
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Class	Sub.	Date	Exmr.
354	069 040 041	9-27-42	Ball
update the above	search clax/sub	4/22/43	Ball
update the above	search clax/sub	7/16/43	Ball

FEE VALUE ACCOUNTABILITY	
DEPOSIT	ACCOUNT NO.
08	2727
FEE CODE	VALUE FURNISHED
1-16	
1-17	

SEARCH NOTES		
	Date	Exmr.

Class	Sub.	Date	Exmr.
359	40 69	7/17/43	Rea

(54) LIQUID CRYSTAL DISPLAY ELEMENT

(11) 2-214822 (A) (43) 27.8.1990 (19) JP

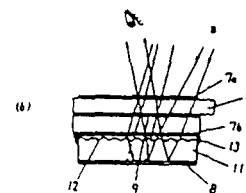
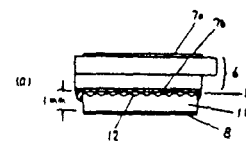
(21) Appl. No. 64-36775 (22) 16.2.1989

(71) MATSUSHITA ELECTRIC IND CO LTD (72) TERUHISA ISHIHARA(1)

(51) Int. Cl. G02F1/1335, G02B5/02

PURPOSE: To obtain the liquid crystal display element which has no shades of display patterns on a reflecting plate and has excellent visibility by diffusing the light past a liquid crystal cell by a light diffusion plate having a rugged surface or a light diffusion plate fixed with many transparent beads.

CONSTITUTION: A 1st polarizing plate 7a and a 2nd polarizing plate 7b are provided on both surfaces of the liquid crystal cell 6. The light diffusion plate 11 is one-side ground glass having the rugged surface 12 and the reflecting plate 8 consisting of a polyester film deposited with aluminum by evaporation is provided on the smooth surface thereof. This light diffusion plate 11 and the reflecting plate 8 are fixed in the form of being superposed on the 2nd polarizing plate 7b to the liquid crystal cell 6. The display patterns 9 are, therefore, visible in the same manner as heretofore, but the light past the liquid crystal cell 6 is diffused by the rugged surface 12 of the light diffusion plate 11. The formation of the distinct shadows is averted in this way and the double appearance of the display patterns is obviated. The extremely good visibility is thus obt'd.



a: light

54) MANUFACTURE OF LIQUID CRYSTAL DISPLAY
UNIT

- 11) Kokai No. 52-68400 (43) 6.7.1977 (21) Appl. No. 50-143962
22) 12.5.1975
71) HITACHI SEISAKUSHO K.K.
72) HIRONARI TANAKA (2)
52) JPC: 101E9;101E5;104G0
51) Int. Cl.³. G09F9/00,G02F1/13

PURPOSE: To increase transparency of diffusion surface by giving etching process after mechanical polish of light diffusion surface of semiconductor of liquid crystal display unit.

CONSTITUTION: When electric field is applied between upper electrode 2a and lower electrode 2b opposing to desired pattern, the liquid crystal at that area loses light emission function and incident rays which passed deflecting plate 6a is shut out by deflection plate 6b. Here, the light diffusion surface receives polish etching to lower light diffusion property a little, and has increased transparency. Therefore, the external light which passed through plate 6a has extremely decreased diffusion light quantity, so that most of the light transmits light director 7 and is then reflected at surface 7b. Thus, the display pattern can be read extremely easily. In this structure, the production of light diffusion surface is facilitated only by addition of etching process with increased transparency. As a result, the incident transmittance of external light is greatly increased to display pattern extremely clearly. At the same time, instantaneous and clear reading of the display becomes possible due to betterment of directivity of light reflection surface 7b.

IBM Technical Disclosure Bulletin

Vol. 33 No. 18 June 1990

259/69

POLARIZED BACKLIGHT FOR LIQUID CRYSTAL DISPLAY

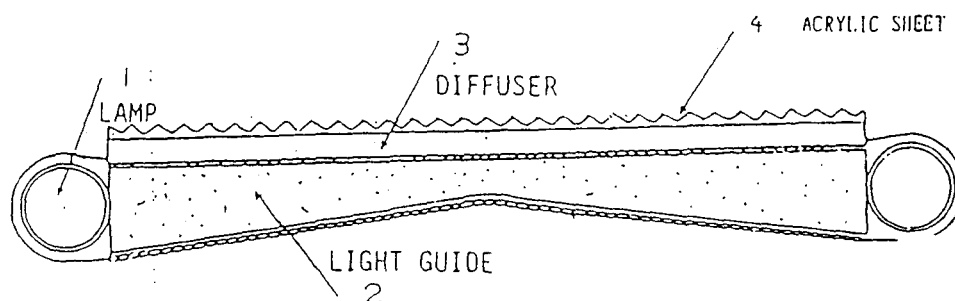


Fig. 1

Disclosed is a backlight device for a transmissive liquid crystal display. This device emits a polarized light whose polarizing axis is parallel with that of a polarizer located on one side of a liquid crystal cell and near the backlight so that the light can pass through the polarizer more than a non-polarized light.

Light which has no polarization from a backlight into the liquid crystal cell has uniform electromagnetic field for 360 degrees. Theoretically, 50 percent of electromagnetic field is absorbed and 50 percent is transmitted by the polarizer. In actuality, 58 percent of electromagnetic field is absorbed and 42 percent is transmitted.

With reference to Fig. 1, the backlight disclosed herein consists of fluorescent lamps 1, an acrylic transparent light guide 2, an acrylic translucent diffuser 3, and an acrylic sheet 4 which has an indented cross-section. Light emitted from the fluorescent lamps 1 is conducted through the light guide 2 by the law of total reflection and is scattered by the diffuser 3 for the purpose of uniform luminance. The acrylic sheet 4 not only optimizes the emitting direction of light by varying the indentation angle but also polarizes the light. Fig. shows a rotation angle versus luminance measured with a polarizing prism. In this case, the acrylic sheet has a indentation angle of 90

POLARIZED BACKLIGHT FOR LIQUID CRYSTAL DISPLAY - Continued

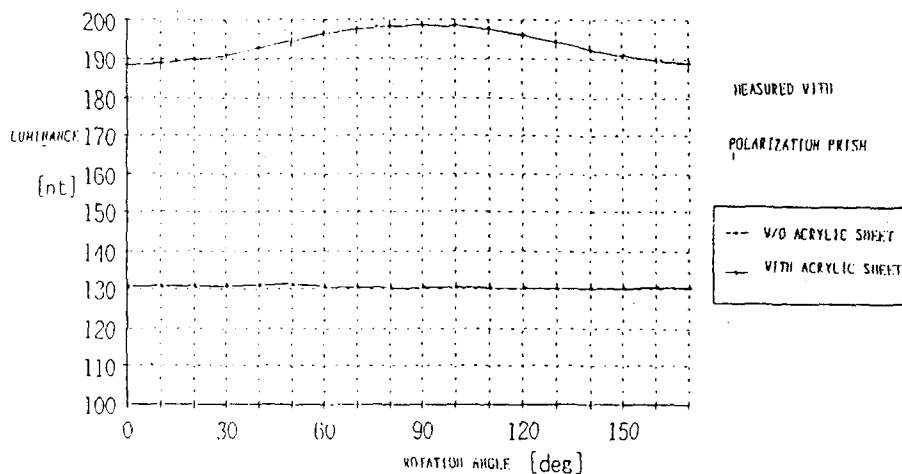


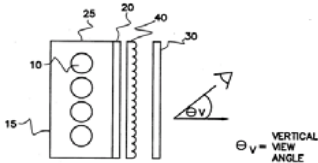
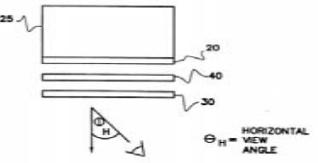
Fig. 2

degrees. This chart shows that luminance changes according to the rotation angle, that is to say, the light has polarization. Five percent of luminous increase is achieved by arranging a polarizing axis of the polarizer and transmissive axis of the acrylic sheet parallel.

In the above example, 5 percent of luminous increase is achieved in consequence of 5 percent of polarization of light. In case linear polarization of light is accomplished, the backlight device makes it possible to eliminate the polarizer located on the backlight side of the liquid crystal cell.

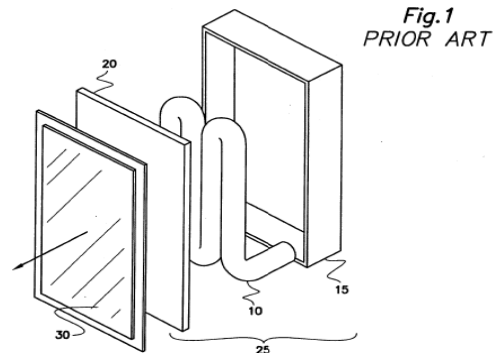
EXHIBIT C

UNITED STATES PATENT 5,280,371
JOINT CLAIM CONSTRUCTION CHART
CLAIM 3

<u>Claim Language*</u>	<u>Honeywell's Construction</u>	<u>Manufacturer Defendants' Construction</u>
<p>A <u>display apparatus comprising</u>:</p>	<p>A display apparatus is a direct view LCD module.</p> <p><i>See, e.g., Col. 2, ll. 51-55:</i></p> <p style="padding-left: 40px;">. . . liquid crystal panel comprised of a number of individual liquid crystal elements which are alternatively energized in order to form a desired pattern image for viewing from the front of the liquid crystal display.</p> <p>File History p. 60 - Amendment and Response to Office Action dated February 2, 1993, p. 3 (distinguishing between projection apparatus and direct view displays); Figs. 4A and 4B.</p> <div style="text-align: center;">  <p>Fig. 4A</p> </div> <div style="text-align: center;">  <p>Fig. 4B</p> </div> <p>The term comprising signifies that this claim is open-ended; it is not limited to only the recited claim elements, but covers an apparatus that contain additional unclaimed components.</p>	<p>A liquid crystal display (LCD) module, i.e., the light source, lens arrays and liquid crystal panel. <i>See, e.g. Col. 1 line. 63 - col. 2 line 1 (SUMMARY OF THE INVENTION).</i></p>
<p>a <u>light source</u>;</p>	<p>A light source for illuminating the claimed liquid crystal panel.</p> <p><i>E.g., Lamp 10 (Figs. 1, 2, 4A, 7 and 10); Col. 5, ll.</i></p>	<p>A source of distributed light. <i>See col. 2 lines 46-51; col. 3 lines 24-29. Figs. 1 and 2.</i></p> <p><i>Referring now to FIG. 1 there is shown a cross section of a typical prior art liquid crystal display</i></p>

*Disputed claim limitations are underlined.

UNITED STATES PATENT 5,280,371
JOINT CLAIM CONSTRUCTION CHART
CLAIM 3

<u>Claim Language*</u>	<u>Honeywell's Construction</u>	<u>Manufacturer Defendants' Construction</u>
	<p>34-38:</p> <p>This allows the reduction of the thickness or optical density of the conventional diffuser while still achieving the same system luminance uniformity and masking of undesired spatial artifacts from the light source, but with higher luminance at the output.</p> <p>File History, p. 53 - Office Action, dated September 30, 1992, p. 2 referencing lamps in Abileah '783 patent ("Abileah et al teach a light source 100. . .").</p>	<p><i>apparatus including backlight array 25 comprising lamp 10, rear reflecting surface 15 and lambertian diffuser 20. <u>The backlight array provides a source of light</u> which impinges on liquid crystal panel 30</i></p> <p><i>Col. 2 lines 46-51.</i></p> <p><u><i>The apparatus of the present invention includes the backlight array and liquid crystal of the prior art as shown in FIG. 1</i></u> with the addition of a lens array 40 inserted between the lambertian diffuser 20 of the prior art and liquid crystal display panel 30, as shown in FIG. 2.</p> <p><i>Col. 3 lines 24-29.</i></p> <div style="text-align: right;">  </div>
a liquid crystal panel mounted adjacent to said light source for receiving light from said light source; and	A liquid crystal panel is mounted near the light source and receives light from the light source.	Defendants agree with Honeywell's construction of this limitation.

*Disputed claim limitations are underlined.

UNITED STATES PATENT 5,280,371
JOINT CLAIM CONSTRUCTION CHART
CLAIM 3

<u>Claim Language*</u>	<u>Honeywell's Construction</u>	<u>Manufacturer Defendants' Construction</u>
<u>first and second lens arrays, each having a plurality of individual lenslets,</u>	<p>A lenslet is a light-refracting structure. <i>E.g.</i>, Col. 3, ll. 60-63. A lens array is a structure that contains a pattern of independently operating light refracting structures (lenslets).</p> <p><i>E.g.</i>, Fig 7, Els. 42 and 44; Fig. 10, El. 80; Figs. 2 and 6, El. 40; Col. 5, ll. 6-15:</p> <p>It was also discovered that the maximum increase in luminance was obtained using a triangular lens array having an included angle of 90° as illustrated in Fig. 10. This configuration resulted in a variation of luminance with vertical and horizontal viewing angles which was quite steep as illustrated by curves 160 and 170 of Fig. 11. Other lens array shapes may be selected as desired to obtain the required concentration of luminance and variation of luminance with vertical and horizontal viewing angle for a particular application.</p> <p><i>See also</i> File History, pp. 33-34 - Original Application, dated July 7, 1992, claims 1-3 and 6.</p>	<p>I) Two lens arrays each consisting of a member separate from the light source and having a plurality of lenslets. <i>See col. 1 line 67 - col. 2 line 3; col. 3 lines 24-52; Figs. 2, 4A, 4B, 6, 7, 10.</i></p> <p>II) The lens arrays are arranged such that the lenslets on the first and second lens arrays:</p> <p>a) face toward the liquid crystal panel (<i>See col. 2 lines 15-18, 22-40; col. 3 lines 50-56; col. 4 lines 46-58; col. 5 lines 6-12; Figs. 2, 4A, 5 - 11</i>);</p> <p>b) are parallel to each other, and parallel to the horizontal axis of the liquid crystal panel (aside from any "slight misalignment") (<i>See col. 1 lines 33-39; col. 1 line 62 - col. 2 line 3; col. 2 lines 32-33; col. 3 lines 1-14; col. 4 lines 26-34; col. 4 line 52 - col. 5 line 5; Figs. 7, 8</i>);</p> <p>c) have different pitches from each other and from the liquid crystal panel (<i>See col. 4 lines 26-45; col. 4 line 59 - column 5 line 5; Fig. 7</i>); and</p> <p>d) provide a variation of light transmission with vertical viewing angle. <i>See col. 1 lines 33-39; col. 1 line 62 - col. 2 line 3; col. 4 lines 52-58; Figs. 2, 4A, 6, 7, 10.</i></p> <p>Exemplary Intrinsic Support for I):</p> <p><i>The foregoing and other objects are achieved in the present invention wherein there is provided ...<u>one or more directional diffuser lens arrays disposed</u></i></p>

*Disputed claim limitations are underlined.

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JOINT CLAIM CONSTRUCTION CHART
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<u>Claim Language*</u>	<u>Honeywell's Construction</u>	<u>Manufacturer Defendants' Construction</u>
		<p><u>between the light source and the liquid crystal array....</u></p> <p>Col. 1 line 62 - col. 2 line 1 (SUMMARY OF THE INVENTION).</p> <p>The apparatus of the present invention includes the backlight array and liquid crystal of the prior art as shown in FIG. 1 <u>with the addition of a lens array 40 inserted between the lambertian diffuser 20 of the prior art and liquid crystal display panel 30,</u> as shown in FIG. 2. It was found that <u>by inserting a directional diffuser consisting of a cylindrical lens array 40 between the lambertian diffuser and the liquid crystal panel</u> that both of the desired effects could be accomplished.</p> <p>...</p> <p>For example, FIG. 5 illustrates that with <u>the insertion of lens array 40</u> as shown in FIGS. 4A and 4B</p> <p>...</p> <p>The effect which results <u>from the insertion of the cylindrical lens array</u> is explained by reference to FIG. 6...</p> <p>Col. 3 lines 24-52.</p> <p>Exemplary Intrinsic Support for II)a:</p>

*Disputed claim limitations are underlined.

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<u>Claim Language*</u>	<u>Honeywell's Construction</u>	<u>Manufacturer Defendants' Construction</u>
		<div data-bbox="1386 305 1890 698"> <p style="text-align: right;">Fig. 6</p> </div> <p data-bbox="1281 730 1974 909"><i>The effect which results from the insertion of the cylindrical lens array is explained by reference to FIG. 6 <u>wherein there are shown light rays from the lambertian ... source diffuser</u> impinging on the lens array from various angles.</i></p> <p data-bbox="1281 925 1554 966"><i>Col. 3 lines 50 - 54.</i></p> <p data-bbox="1281 1039 1764 1079">Exemplary Intrinsic Support for II)b:</p> <div data-bbox="1491 1088 1806 1380"> <p style="text-align: center;">Fig. 7</p> </div> <p data-bbox="1281 1396 1764 1437">Exemplary Intrinsic Support for II)c:</p>

*Disputed claim limitations are underlined.

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<u>Claim Language*</u>	<u>Honeywell's Construction</u>	<u>Manufacturer Defendants' Construction</u>
		<p><i>For the desired specific implementation it was discovered that <u>the adverse interaction producing moire patterns could be eliminated by including a second lens array with a different number of lenses per inch. The combination of the dual lenses</u> increased the desired reduction in luminance with increased viewing angle, and in addition <u>reduced or eliminated the moire patterns with the selection of an appropriate pitch, or number of lenses per inch, for the two lenses</u> in question.</i></p> <p><i>As illustrated in FIG. 7, one of the lens arrays 42 was selected to have a relatively coarse pitch with respect to that of the liquid crystal display and the second lens array 44 was selected to have a relatively fine pitch with respect to that of liquid crystal display.</i></p> <p><i>...</i></p> <p><i>In addition, since <u>moire effects result when both of the lens arrays have the same spatial frequency</u>, the rear array 42 should have a coarse resolution or low spatial frequency while the front lens array 44 should have a fine resolution or high spatial frequency. <u>The lens arrays and the panel spatial frequencies should be selected to avoid integral multiples of the other.</u></i></p> <p><i>Col. 4 lines 26-65.</i></p>

*Disputed claim limitations are underlined.

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JOINT CLAIM CONSTRUCTION CHART
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<u>Claim Language*</u>	<u>Honeywell's Construction</u>	<u>Manufacturer Defendants' Construction</u>
		<p>Exemplary Intrinsic Support for II)d:</p> <p><i>In certain applications, such as for example an aircraft cockpit, <u>the typical vertical viewing angle is fixed within a relatively narrow range and it would therefore be desirable to concentrate a higher percentage of the energy from the light source within a particular range of viewing angles.</u></i></p> <p><i>Col. 1 lines 33-39.</i></p> <p><i>The foregoing and other objects are achieved <u>in the present invention</u> wherein there is provided a liquid crystal display apparatus...<u>for providing a tailored variation of luminance from the liquid crystal display as a function of vertical viewing angle.</u></i></p> <p><i>Col. 1 line 62 - col. 2 line 3 (SUMMARY OF THE INVENTION).</i></p> <p><i><u>For the particular application in question the preferred embodiment</u> included two lens arrays in series which <u>provided the best tradeoff of decrease in luminance with variation of vertical viewing angle, while not adversely affecting the variation in luminance with horizontal viewing angle.</u></i></p> <p><i>Col. 4 lines 52-58.</i></p>
disposed between said light source and said	No Construction Necessary	Positioned between the light source and the liquid crystal panel, with a purposeful and defined air gap at

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<u>Claim Language*</u>	<u>Honeywell's Construction</u>	<u>Manufacturer Defendants' Construction</u>
<u>liquid crystal panel</u>		the interface of the light source and the one of the lens arrays closest to the light source. <i>See col. 3 lines 26-28, 55-56; col. 4 lines 4-16; Fig. 6, and originally filed Fig. 6:</i> <u>An air gap must be present</u> at the interface of the lambertian diffuser and the lens array. <i>Col. 3 lines 55-56.</i>
<u>for providing a predetermined variation with viewing angle of light transmission from said light source through said lens arrays and said liquid crystal panel,</u>	The lens arrays provide a variation of light transmission with viewing angle; as a result of the arrays, the transmission of light through the liquid crystal panel varies with the angle from which the panel is viewed. <i>See e.g., Col. 1, ll. 8-10, 36-45, 48-61:</i> . . . a liquid crystal display (LCD) having a directional diffuser to provide a tailored variation of luminance with viewing angle. * * * . . . it would therefore be desirable to concentrate a higher percentage of the energy from the light source within a particular range of viewing angles. It would therefore be desirable to provide a directional diffuser for use with a liquid crystal display to provide a tailored variation of luminance with viewing angle while also providing a	See II(d), <i>infra</i> .

*Disputed claim limitations are underlined.

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<u>Claim Language*</u>	<u>Honeywell's Construction</u>	<u>Manufacturer Defendants' Construction</u>
	<p>concentration of the light energy from the light source within a predetermined range of viewing angles.</p> <p style="text-align: center;">* * *</p> <p>It is therefore an object of the present invention to provide a directional diffuser element for a liquid crystal display to provide a tailored variation of luminance with viewing angle.</p> <p>It is a further object of the present invention to provide a liquid crystal display having less variation of intermediate gray-level luminance with viewing angle.</p> <p>It is still further an objection of the present invention to provide a liquid crystal display combining the above features to provide a higher concentration of light energy, and therefore increased luminance, within a particular range of viewing angles thereby providing a more efficient use of light energy available from a light source.</p> <p><i>See also</i>, Col. 3, ll. 19-24:</p> <p>It would therefore be more energy efficient if a substantial portion of the light energy could be redirected so as to be concentrated in the viewing angles of</p>	

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JOINT CLAIM CONSTRUCTION CHART
CLAIM 3

<u>Claim Language*</u>	<u>Honeywell's Construction</u>	<u>Manufacturer Defendants' Construction</u>
	<p>interest for a particular application.</p> <p><i>See</i>, Col. 3, ll. 60- Col. 4, l. 16:</p> <p>Those rays that are normal to the source diffuser but less than the critical angle within the lens array are passed through the lens array materially unobstructed, except for a small amount of surface reflection. Rays which enter at oblique angles and are greater than the critical angle of the lens array undergo total internal reflection at the inside of the lens surface as illustrated by ray tracing 70. These rays are reflected with no loss due to the total internal reflection effect around the lens periphery. They exit the rear of the lens array and return to the source diffuser where they undergo a secondary diffuse reflection from the source diffuser.</p> <p>However, because the source diffuser is not totally reflective, some of the returned rays are transmitted through the diffuser and are then reflected from the backlight enclosure surface 15 of Fig 4A. Some fraction of these rays are reflected internally to exit the diffuser again. These reflected rays again have a lambertian distribution at the surface of lambertian diffuser 20. It is apparent from this interaction between the lens</p>	

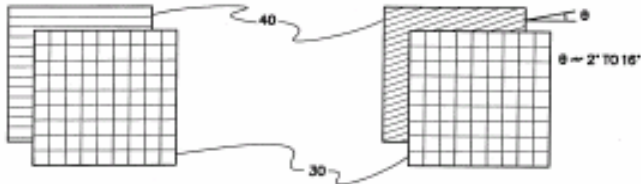
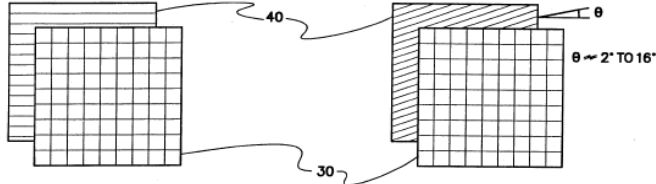
*Disputed claim limitations are underlined.

UNITED STATES PATENT 5,280,371
JOINT CLAIM CONSTRUCTION CHART
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<u>Claim Language*</u>	<u>Honeywell's Construction</u>	<u>Manufacturer Defendants' Construction</u>
	<p>array and the backlight that rays which impinge close to the normal tend to be intensified while those rays which impinge at oblique angles undergo total internal reflection and are returned to the diffuser and diminished somewhat from this statistical process.</p> <p>Col. 5, ll. 6-15:</p> <p>It was also discovered that the maximum increase in luminance was obtained using a triangular lens array having an included angle of 90° as illustrated in Fig. 10. This configuration resulted in a variation of luminance with vertical and horizontal viewing angles which was quite steep as illustrated by curves 160 and 170 of Fig. 11. Other lens array shapes may be selected as desired to obtain the required concentration of luminance and variation of luminance with vertical and horizontal viewing angle for a particular application.</p>	
<p><u>wherein at least one of said first and second lens arrays is rotated about an axis perpendicular to said liquid crystal panel in order to provide a slight misalignment between</u></p>	<p>A slight misalignment is a misalignment of typically 2-16 degrees between an axis of the lens array and an axis of the pixel arrangement in the liquid crystal panel.</p> <p><i>See e.g., Col. 5, ll. 21-28:</i></p> <p>This residual moiré can be removed by rotating the lens array 40 with the</p>	<p>One or more of the lens arrays is intentionally rotated at an angle of not less than 2 degrees and not more than 16 degrees in relation to the horizontal axis of the liquid crystal panel. <i>See col. 2 lines 40-42; col. 5 lines 16-28; Fig. 12.</i></p> <p><i>FIG. 12 shows the angular rotation of the lens array <u>with respect to the LCD matrix array</u> to</i></p>

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<u>Claim Language*</u>	<u>Honeywell's Construction</u>	<u>Manufacturer Defendants' Construction</u>
<p><u>said lenslets and said liquid crystal panel.</u></p>	<p>respect to the LCD array 30, as illustrated in Fig. 12. This rotation of the lens array by a few degrees (Typically 2 to 16 degrees) from the horizontal axis causes a small change in the effective spatial frequency difference of the two arrays and thereby eliminates the residual moiré.</p> <p>Fig. 12:</p>  <p style="text-align: center;">Fig. 12</p> <p>; File History, pp. 33 & 35 - Original Application, dated July 7, 1992, claims 1-3 and 9.</p>	<p><i>eliminate residual moiré effects.</i> <i>Col. 2 lines 40-42.</i></p> <p><i>This residual moire can be removed by rotating the lens array 40 <u>with the respect to the LCD array 30,</u> as illustrated in FIG. 12. <u>This rotation of the lens array by a few degrees (Typically 2 to 16 degrees) from the horizontal axis</u> causes a small change in the effective spatial frequency difference of the two arrays and thereby eliminates the residual moire.</i> <i>Col. 5 lines 21-28.</i></p>  <p style="text-align: center;">Fig. 12</p>

*Disputed claim limitations are underlined.

EXHIBIT D

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

HONEYWELL INTERNATIONAL INC. and)	
HONEYWELL INTELLECTUAL PROPERTIES INC.,)	C.A. No. 04-1338-MBT
)	(Consolidated)
Plaintiffs,)	
)	
v.)	
)	
APPLE COMPUTER, INC., et al.,)	
)	
Defendants.)	
)	

Expert Report for Defendants FUJIFILM Corporation, FUJIFILM U.S.A., Inc., Samsung
SDI Co., Ltd., Samsung SDI America, Inc., and Optrex America Inc. on Invalidity and
Unenforceability
by
Dr. Elliott Schlam

Public Version

shown in Fig. 2. The lenslets of the lens array face in the direction of the liquid crystal panel. This configuration is clearly seen in Figs. 2, 4A, 6, 7 and 10.

65. A lambertian diffuser 20 (which was known prior to the filing of the '371 patent and the date the invention was made claimed by Honeywell) essentially diffuses the irregular pattern of light coming from the back of the backlight (caused by, in the case of the '371 patent, the use of a serpentine-shaped lamp 10) to light that is more uniformly distributed across the area of the backlight and has essentially the same luminance regardless of the angle at which one views the light coming from the backlight. A lambertian diffuser helps ensure that the image created by the LCD is not distorted by an irregular light pattern shining through it. This irregularity is generally caused by the finite nature of the light source itself, such as a linear or serpentine shaped cold cathode fluorescent lamp ("CCFL") or point source light emitting diode ("LED") or groups of LEDs. The use of side lit backlights was known prior to the earliest date of reduction to practice of the '371 patent claimed by Honeywell but is not disclosed in the '371 patent.

66. The '371 patent describes that inserting one or more lens arrays, each with an array of horizontally extending lenslets, referred to by the applicants as "directional diffusers," between the lambertian diffuser and the liquid crystal panel to concentrate the overall light energy within a range of vertical angles. See, for example, the '371 patent, col. 3 lines 37 – 43 (single lens array); Fig. 8.

67. A person of ordinary skill in the art would have understood from reading the '371 patent that an air gap must be present at the interface of the lambertian diffuser (light source) and the adjacent lens array. "An air gap must be present at the interface of the lambertian diffuser and the lens array." See the '371 patent, col. 3 lines 55-56. An air gap ensures that light is refracted

by the change in index of refraction as it travels between different materials, as when the light leaves the lambertian diffuser, travels through the air and enters the lens array, as can be seen in Fig 6.

68. An air gap as described in the specification of the '371 patent must include a well-defined space between the lambertian diffuser and lens array. An LCD module normally does not have a built-in "air gap" (as that term is used in the '371 patent) even though there may be random points between the lambertian diffuser and the lens array where the lens components do not touch. An "air gap" (as used in the '371 patent) requires the LCD module designer to take affirmative steps, such as incorporating a physical spacer between the two components and ensuring that the components are stiff enough to produce the gap. Random points of contact would adversely affect the operation of the device by creating blemishes or irregularities on the display.

69. The drawings submitted with the original application actually identified the space between the diffuser 20 and the lens array 40 of Fig. 6 as an "AIR GAP." The term was removed when the final drawings were submitted on October 4, 1993.

70. Upon review of the '371 patent, it is evident that applicants experienced "significant moiré patterns" when a single lens array containing 142 lenses per inch and the display panel matrix had a spatial frequency resolution of 172 dots or pixels per inch. See '371 patent, col. 4, lines 20-25. One skilled in the relevant art would not be surprised by the existence of moiré interference in this situation because of the similarity of pitches and alignment of the two patterns in question.

71. The '371 patent specification discusses that the adverse interaction producing moiré patterns could be eliminated (or at least minimized) by including two lens arrays with the

148. I have reviewed the patent and this meaning is clear on its face. The '371 specification refers to "a lens array 40 inserted between the lambertian diffuser 20 of the prior art and liquid crystal display panel 30" See '371 patent at col. 3, lines 26-28. It also states: "An air gap must be present at the interface of the lambertian diffuser and the lens array." See '371 patent at col. 3, lines 55-56. One of ordinary skill in the art, reading the specification's use of the word "must" would understand that an air gap must be present in order to create the change in index of refraction that occurs as the light enters the lens array from the air gap. See for example light ray 70 in Fig. 6, which also shows an air gap between diffuser 20 and lens array 40 and the version of Fig. 6 filed with the application which labels the space between diffuser 20 and lens array 40 as an "AIR GAP." Ex. D2 (application).

7. at least one of the lens arrays is rotated about an axis perpendicular to the liquid crystal panel in order to provide a slight misalignment between said lenslets and said liquid crystal panel

149. The term should be interpreted to mean one or more of the lens arrays is intentionally rotated at an angle of not less than 2 degrees and not more than 16 degrees in relation to the horizontal axis of the liquid crystal panel.

150. I have reviewed the patent and this meaning is clear on its face. The '371 specification states: "Even though the spatial frequencies of the directional diffuser lens array and LCD panel have been selected to be greatly different and non-integer multiples, some visual banding effects or moiré pattern effects may still be apparent to the viewer. This is especially true at off-axis viewing conditions. This residual moiré can be removed by rotating the lens array 40 with the respect to the LCD array 30, as illustrated in FIG. 12. This rotation of the lens array by a few degrees (Typically 2 to 16 degrees) from the horizontal axis causes a small change in the effective spatial frequency difference of the two arrays and thereby eliminates the residual

15a, 15b are essentially lens arrays, having either convex-concave lenslets 16a, 16b or triangular prismatic lenslets. See, for example, par. 0014. The lenslets on each directional sheet 15a, 15b face toward the panel 10. The directional sheets 15a, 15b (and their respective lenslets) are crossed at 90 degrees relative to each other to achieve desired luminance. See, for example, pars. 0011 and 0012.

225. In the alternate embodiments of Figs. 3 and 6 only one directional sheet 15 is used. Unlike the embodiments of Figs. 1 and 2, in which the lenslets of the directional sheets are orthogonal to the edges of the liquid crystal panel, the lenslets of sheet 15 are rotated, such that they are disposed at a diagonal with respect to the pixel arrangement of the panel. See pars. 0011 and 0019.

226. The application also acknowledges that moiré interference can be created between the lenslets of the directional sheets 15 and the pitch of the pixels of the liquid crystal panel 10. See par. 0008. More specifically, the application explains moiré interference is created by interference between the lenslets and the pixel electrodes of the panel 10. See par. 0017. The application explains that each of the crossed directional sheets 15a, 15b configuration and the rotated sheet 15 configuration eliminates the moiré interference. See pars. 0018 and 0019.

X. SUMMARY AND ANALYSIS OF THE PRIOR ART

A. Use of one or two lens arrays to provide a predetermined variation with viewing angle of light transmission from the light source through the lens array(s) and a liquid crystal panel

227. In the case of direct view LCD systems, it was well known to persons skilled in the art to use a lens array between a light source and a liquid crystal panel to shape and determine the viewing angle of the LCD system. It was known in the art that the light varies in a direction orthogonal to the direction of the lenslets and the plane of the lenslets of a lens array.

For example, the variation of light occurs in a plane perpendicular to the lens array and perpendicular to the direction of light.

a. the IBM High Efficiency Back Light Article (Ex. G1 (pars. 175-176)) teaches the use of a lens array (“micro-prism-plate”) facing toward the liquid crystal panel which redirects the light from the light source (light guide) to provide a predetermined variation with viewing angle (a narrower viewing angle) of light transmission from the light source through the lens array and the liquid crystal panel to reduce power consumption in a portable device. While the IBM High Efficiency Back Light article is silent as to whether the predetermined variation is in a horizontal or vertical viewing angle, one skilled in the art would know that the variation can be in either direction, depending on the intended application and adjust the direction of the micro-prism-plate accordingly.

b. the ‘041 Abileah patent (Ex. E5 (pars. 180-182)) teaches the use of two crossed lens arrays 202, which redirect the light from the light source 200 toward the liquid crystal panel 205 to provide a predetermined variation with viewing angle (a narrower viewing angle in both the horizontal and vertical directions) of light transmission from the light source through the lens array and the liquid crystal panel to reduce power consumption in avionic and portable devices. One skilled in the art would know to have the lenslets in the two lens arrays extend in the same direction if variation with viewing angle in only one direction (e.g. horizontal) was desired.

c. the IBM Polarized Backlight Article (Ex. E8 (par. 177)) teaches the use of a lens array (“acrylic sheet” with a lenticular structure) facing toward the liquid crystal panel which redirects the light from the light source (light guide 2) to provide a

predetermined variation with viewing angle (a narrower viewing angle) of light transmission from the light source through the lens array and the liquid crystal panel. While the IBM Polarized Backlight Article is silent as to whether the predetermined variation is in the horizontal or vertical direction, one skilled in the art would know that the variation can be in either direction, depending on the intended application and adjust the direction of the micro prism plate accordingly. One skilled in the art would also know that the result is a higher brightness at various viewing angles with a resultant power reduction for the same brightness level.

d. the JP '786 Matsuyama publication (Ex. G2 (par. 183)) teaches the use of two lens arrays (cylindrical (linear) Fresnel lenses 2''a, 2''b and 2'''a and 2'''b) which redirect the light from the light source (tubular lamp 1', 1'', 1''') to provide a predetermined variation with viewing angle (a narrower viewing angle in one or both directions) of light transmission from the light source through the arrays and the liquid crystal panel. A Fresnel lens is an array of individual optical elements that refract light and together simulate a plano-convex cylindrical lens in a sheet form. Each optical element (usually with a triangular cross section and differing in shape from the center to the edge) can be considered an independent lenslet so that each linear Fresnel lens has a plurality of individual lenslets as stated in claim 3 of the '371 patent. Unlike the '041 Abileah patent and the two IBM articles which provide a distributed source of light to the lens arrays, the JP '786 Matsuyama publication provides an undistributed line source of light and, therefore, uses a linear Fresnel lens array in place of a lenticular lens array since the linear Fresnel lens array also serves to distribute light from a line source of light to a broad beam. Compare Fig. 2 of the IBM High Efficiency Back Light Article (Ex